# FATS Added to FEEDS

## An Economic Analysis

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UNITED STATES DEPARTMENT OF AGRICULTURE
Economic Research Service

## PREFACE

This study is part of a broad program of research conducted by the United States Department of Agriculture to assist in the development of markets for agricultural products. A basic part of this program is economic research leading to greater knowledge of industrial markets for agricultural materials. The information on factors affecting use and potential growth of fats and oils in animal feeds is designed to help management in appraising the importance of this outlet, and in making plans for expanding the use of fats and oils in feeds.

This study was conducted under the general supervision of Marshall E. Miller, chief, Market Potentials Branch.

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# FATS ADDED TO FEEDS: AN ECONOMIC ANALYSIS

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## SUMMARY

In the short span of years since World War II, major changes have occurred in the industrial market outlets for fats and oils. There has been a rise in volume of synthetic detergents, and a consequent decline in volume of fats and oils used for soapmaking. The largest single new market which has been developed for fats and oils is in animal feeds.

Among the various industrial outlets for fats, the feed market apparently has the largest potential for growth. An estimated 1.4 billion pounds of fat could be absorbed annually in mixed feeds and feed ingredients in the next decade. Many feed mixers now are adding fat at low levels, and current use is approximately 0.5 billion pounds a year.

Greater quantities of fats are being used in feeds, because of: (1) Increased production of livestock and poultry; (2) increased production of commercial feeds; (3) increased pelleting of feeds; (4) increased bulk handling of feeds; (5) increased use of high-protein, high-energy rations; (6) larger percentages of fats in feeds; (7) increased recognition by feed manufacturers and livestock feeders of the advantages of adding fats to feeds; and (8) growing supplies of tallow and grease with low, relatively stable prices.

A number of factors affect use of fats by individual feed mills. Added fat contributes many nutritional benefits to feeds and acts as an aid in processing as well. In addition to its caloric or energy value, fat increases feed efficiency, reduces dustiness, makes for easier handling, increases palatability, reduces wear on handling, mixing, and other machinery, aids in homogenizing and stabilizing the mixture of fine-particled feed additives, supplies an added growth factor, and gives feed a better appearance. Adding fat to pelleted feeds leads to an increase in pelleting rate, longer service life for pelleting dies, and less wear on pelleting machinery. It also enables manufacturers to make pellets with feeds that otherwise could not be pelleted. These "plus" factors cause feed formulators to use fats, even when the energy-cost ratio for fats is above other energy sources. In a recent year, use of fats continued to expand though cost of fats averaged 34 percent above corn on an equivalent energy basis.

As manufacturers gain experience in adding fats they put them in more types of feeds and increase the fat added to some feeds. Some feed mixers add 1/2 to 2 percent fat to all feeds produced. Farmers' demand for high-efficiency (high-protein, high-energy) feeds is influential in raising the level of fat employed.

Small-volume feed mills and custom grinding and mixing operators are segments of the mixed feed industry least likely to add fats.

Fat is added to practically all commercial dry dog food and to most chicken feeds, particularly layer and broiler feeds. Some broiler feeds in commercial use contain as high as 10 percent of added fat. Many turkey and calf feeds, as well as some hog and beef cattle feeds, contain added fat, but few dairy feeds contain added fat. Feed manufacturers say added fat is especially valuable in feeds for young animals. Adding 1/2 to 3 percent fat to alfalfa meal and solvent-extracted cottonseed meal is rapidly gaining in popularity.

Tallow and grease account for about 90 percent of all fats and oils used in feeds. The limited availability of vegetable oil byproducts confines their use. Ample supplies of tallow and grease are available to sustain high-level use in feeds in years to come. Supply availability frequently determines the kind and grade of fat used. All animal fats added to feeds and feed ingredients are stabilized with antioxidants. There are few reports of stabilized fats going out of condition in recent years.

## INTRODUCTION

A strong need exists for new or improved fats and oils to enable the fats and oils industry to maintain and strengthen its competitive position in food and industrial markets in the United States. Greater use of fat in feeds appeared to be an excellent possibility. Marketing research was devoted first to determining the quantities and types of fats and oils being used in livestock, poultry, and pet feeds and some feed ingredients. Through the Bureau of the Census, a special survey was made to find out the volume going to this outlet in 1956. This study was completed and a report published (6). 1/

The purpose of the present study is to determine the factors governing use, level of use, and manufacturers' considerations when using fats in feeds and feed ingredients and to evaluate the importance of this relatively new outlet for fats and oils. This report deals with fats added to feeds. The roughly 3 percent of fat naturally contained in most formula feeds is recognized, but not included in the analyses of levels of added fats used in various formulations. Mixed-feed manufacturers, oilseed processors, and alfalfa-meal manufacturers were interviewed. Nearly 100 firms participated in the study; their use accounted for over 60 percent of all added fats in feeds.

## FEEDS AS A MARKET FOR FATS

Energy values of feeds have been greatly increased through the addition of fats, which have a high caloric value. This change is characterized by the statement of a feed industry spokesman who said, "Competition in the feed industry today is between feeds with added fat, rather than between feeds with fat added and feeds with no added fat."

1/ Underscored numbers in parenthesis refer to Literature Cited, page 31.

Use of fats in feeds began in a major way in 1953 and since then the Bureau of the Census has maintained a statistical series reporting the consumption of fats in feeds (13). The market for fats in feeds has shown a rapid expansion (fig. 1). Only soapmaking exceeds feeds in importance as a market outlet for tallow and grease in this country although fatty acids are also increasing. The earlier study found 326 million pounds of fat being added to feeds in 1956, more than double the amount used in 1954. More recent reports by the Bureau of the Census indicate that although there has not been a steady increase in use from year to year since 1956, reported consumption for 1960 is about 500 million pounds. Actual use of fats in feeds is greater than the reported figures. Reported figures ignore quantities consumed in on-the-farm feed mixing, oilseed meal processing, as well as alfalfa mills and feed mills that have recently started adding fats to their products.

Fat addition to mixed feeds and feed ingredients could grow to as much as 1.4 billion pounds in the next decade (table 1). This is based on more widespread use of fats in current applications and at present levels of incorporation. If fats were added at higher levels and to additional feeds and feed ingredients this market could absorb more than 1.4 billion pounds of fats in future years. A fuller discussion of the potentials for fats in feeds is presented in a subsequent section of this report.

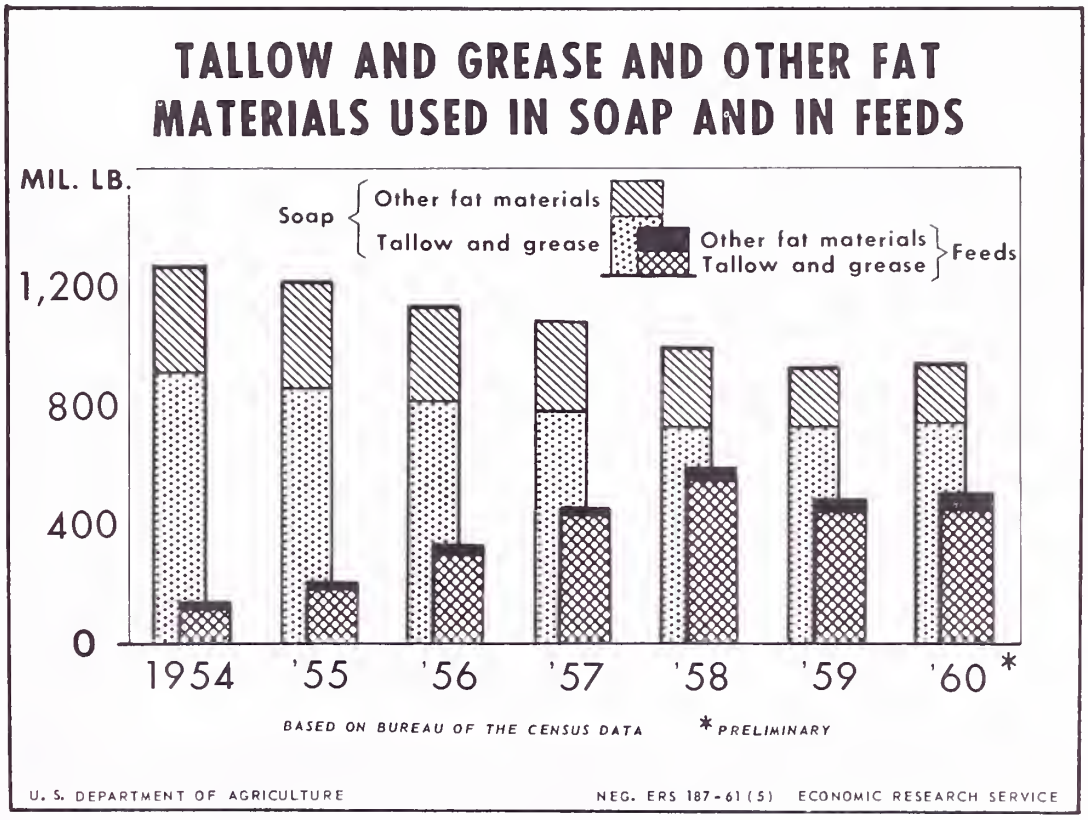


Figure 1

Table 1.--Levels of added fat used and potential fat consumption in commercially prepared feeds and feed ingredients

| Type of feed or feed ingredient | 1958 production 1/ | Levels of added fat: Range | Levels of added fat: Most widely used | | Estimated potential fat consumption |
|---|---|---|---|---|---|
| | Thous. tons | Percent | Percent | Pounds per ton | Million pounds |
| **Poultry feed** | | | | | |
| Chicken mash and pellets: | | | | | |
| Layer and breeder | 4,800 | ½-6 | 3 | 60 | 288 |
| Starter | 1,000 | 1-4 | 2 | 40 | 40 |
| Grower | 1,200 | 1-3 | 2 | 40 | 48 |
| Broiler | 4,800 | 1-10 | 4 | 80 | 384 |
| Turkey mash and pellets | 1,200 | ½-4 | 2 | 40 | 48 |
| Scratch feeds | 700 | -- | - | -- | -- |
| Other complete poultry feeds | 100 | ½-1 | 1 | 20 | 2 |
| Poultry supplements and concentrates | 2,500 | ½-7½ | 4 | 80 | 200 |
| Poultry feeds, not specified | 300 | -- | - | -- | 2/ 6 |
| **Livestock feed** | | | | | |
| Dairy cattle | 4,200 | ½-2½ | 1 | 20 | 84 |
| Beef and range cattle | 1,700 | 1-3 | 2 | 40 | 68 |
| Pig and hog | 1,500 | ½-4 | 2 | 40 | 60 |
| Horse and mule | 300 | -- | - | -- | -- |
| Other complete livestock feeds | 200 | ½-1½ | 1 | 20 | 4 |
| Livestock supplements and concentrates | 3,600 | ½-2 | 1 | 20 | 70 |
| Milk replacer, calf and pig | -- | 3-6 | - | -- | -- |
| Livestock feeds not specified | 300 | -- | - | -- | 2/ 6 |
| Dog and cat feed: | | | | | |
| Canned | 800 | -- | - | -- | -- |
| Biscuits, pellets and meal | 800 | 1-5 | 3 | 60 | 48 |
| Prepared animal feeds, not specified | 3/1,200 | -- | - | -- | 2/ 24 |
| **Feed materials** | | | | | |
| Alfalfa meal: | | | | | |
| Dehydrated | 1,100 | ½-2 | 1 | 20 | 22 |
| Suncured | 100 | 1-3 | 2 | 40 | 4 |
| Soybean meal | 2,400 | -- | - | -- | -- |
| Cottonseed meal-solvent extracted | 4/ 300 | 1-2½ | 1.5 | 30 | 9 |
| Linseed and safflower solvent extracted | 5/ 100 | 1-4 | 3 | 60 | 6 |
| Other oilseed meals, solvent extracted | 50 | -- | - | -- | -- |
| Mineral mixture, including oyster shell | 300 | ½-2 | 1 | 20 | 6 |
| Total | | | | | 1,427 |

1/ 1958 Census of Manufactures, Grain Mill Products (12).
2/ One percent added fat.
3/ Estimated on basis of value.
4/ Solvent extracted cottonseed meal estimated at 29 percent of total production.
5/ Solvent extracted linseed meal estimated at 61 percent of total production.

Two research achievements were basic to this enlarged role of fats in feeds. The first contribution was from nutritionists seeking higher conversion of feed to meat. They found the key was a high energy level obtained from adding fat in combination with higher levels of protein in the feed. This resulted in improvement in the conversion of feed into body-building materials and, therefore, greater feed efficiency. The second was research on control of oxidation and rancidity of fats, leading to antioxidants that were usable with low-cost fats to give them long-term stability when used in animal feeds.

These two developments, combined with expanding livestock and vegetable oil industries and the declining use of fats in soapmaking made possible the greatly expanded use of fats in feeds. Feed manufacturers have become one of the major industrial consumers of domestically produced animal fats and oils.

Over the years, oilseed processing plants have become more efficient in extraction of edible oils from oilseeds. In recent years, many oilseed processors have become both extractors of oil and adders of fat, removing practically all the higher value "edible" oil and replacing a portion with lower cost fats and oils so that their oilseed meals, as sold, still contain a desirable level of fat.

## FACTORS AFFECTING ADDITION OF FATS TO FORMULA FEEDS

### Reasons For Adding Fats

Formula feed manufacturers adding fats gave from one to as many as seven reasons for doing so. Reasons given were influenced largely by the types of feeds made and the forms (pellets, crumbles, mashes, etc.) into which final mixed feeds were processed, as well as the feed nutrition concepts and economics of ingredients employed. Table 2 shows a condensed breakdown of the reasons offered, and the percentage of firms responding in each group.

In naming the most important reason, feed manufacturers gave a variety of answers. Adding fats to feeds is so new that feed mixers, as yet, have had little agreement as to which of the reasons for using fats is most important. Feed mixers can justify use of fat for one or more reasons and be different from each other in their justifications. Almost 3/4 of the firms adding fats, however, said their major interest in adding fats was feeding value. About 40 percent said for energy benefit, 19 percent said feed efficiency, and 14 percent said nutrition benefit. Among the remainder, 8 percent said they added fat to improve feed appearance, 6 percent said to give added palatability, and another 6 percent said to improve feed texture.

Since each feed maker could also give all his reasons for adding fat, part of table 2 is largely a "frequency of mention" tabulation. By the grouping used, physical effects on feeds were mentioned most often (48 percent), and feeding value was mentioned next most frequently (37 percent).

Table 2.--Feed manufacturers' reasons for adding fats

| General reasons, and other descriptive terms used by the trade | Percentage of firms listing a reason as most important | Percentage of all reasons 1/ |
|---|---|---|
| | Percent | Percent |
| PHYSICAL | 22 | 48 |
| Improves feed appearance (Dressing; rich look; dress up the feed; brighten up the feed; eye appeal) | 8 | 14 |
| Reduces dustiness (Cuts down dust in bulk shipments; less dust in mash) | - | 12 |
| Increases palatability (Animals like fatty feed better) | 6 | 10 |
| Improves texture (Conditioning; conditions feed, gives good texture; effect on texture; enhancement of texture) | 6 | 7 |
| Easier handling | 2 | 2 |
| Stabilizes the stratification of mixed feed (Stabilizes the blend of feed ingredients during shipment) | - | 2/ |
| Improves physical properties (Could apply to all reasons in this category) | - | 2 |
| FEED VALUE | 74 | 37 |
| Energy (Calorie content; energy value; higher calorie level; productive energy; concentrated energy) | 39 | 18 |
| Nutrition (Good in starter feeds for young animals; nutritional improvement of some feeds; raise fat content of low fat feeds; adjust calorie-protein ratio; balanced diet; nutritional balance) | 14 | 8 |

Table 2.--Feed manufacturers' reasons for adding fats—Continued

| General reasons, and other descriptive terms used by the trade | Percentage of firms listing a reason as most important | Percentage of all reasons 1/ |
|---|---|---|
| | Percent | Percent |
| Improves feed efficiency | 19 | 8 |
| (Better feed conversion; improves performance of livestock; get better results; lowers cost of production of meat and eggs; lowers cost of producing poultry meat) | | |
| Added growth factor | 2 | 1 |
| (Increases growth) | | |
| Produces larger eggs | - | 2/ |
| Cuts down bloating | - | 2/ |
| Improves quality of chicken | - | 2/ |
| Helps digestion of feed | - | 2/ |
| FABRICATION | - | 3/10 |
| Aid in pelleting | - | 5 |
| (Improvement in pelleting; effect on pelleting; increases pellet production rate; increases pelleting speed; increases pellet mill capacity) | | |
| Less wear and tear on machines | - | 5 |
| Reduces wear and tear on equipment; lubrication of machinery; reduces wear on pelleting machinery; increases die life; less wear on dies) | | |
| ECONOMIC | 4 | 5 |
| Trade demand | 4 | 5 |
| (Acceptance by trade; recommended; demand for high energy feed; sales advantage; competitive pressure) | | |
| Grand total | 100 | 100 |

1/ Firms were not limited in number of reasons they could give for adding fat. The number varied from 1-7 reasons.

2/ Less than 1 percent.

3/ Reduces dustiness (12 percent) and easier handling (2 percent) are also fabrication advantages; including these raises fabrication subtotal to 24 percent.

## Percentage of Fat Added

The levels of fat added commercially by the feed industry to various types of feeds are shown in table 1. Considerable variation occurred between types of feeds in the level of fat added. Some types of commercial feeds, such as scratch feeds, have no fat added, while other types, such as broiler feeds, contain as much as 10 percent added fat. Highest commercial levels of added fat found in feeds were: broiler 10 percent, poultry concentrate 7-1/2 percent, layer and breeder 6 percent, milk-replacer (calf and pig) 6 percent, and dog and cat (dry) 5 percent. Some feeds for young livestock such as calves, pigs, and turkey poults contained as much as 4 percent added fat. For optimum dust control and physical appearance benefits in mash feeds, most feed manufacturers currently adding fats felt that 1 to 3 percent fat (depending on formula and grind) should be added.

Table 3 shows what feed mixers consider when they determine the level of fat to add to formula feeds. As with reasons for adding fats, users each gave one or more level-determining factors. Feeding values were named most frequently (41 percent), next were economic (23 percent), third were physical (20 percent), and then fabrication (16 percent).

## Choice Between Fats and Other Energy Ingredients

More than a direct consideration of cost of energy from one source or another enters into the decision to use fats or other high-energy ingredients. In some instances it is the overall cost of obtaining all advantages of added fat. As users pointed out, addition of fat has a number of plus values outside its direct nutritional effect. It was mentioned that (1) fat makes possible higher energy rations than can be made from grain alone, (2) animals like feeds with added fat better than most feeds composed of other energy ingredients, (3) added animal fats are practically an essential in pet foods, (4) added fat increases feed efficiency of the whole ration, (5) fabrication advantages are much greater when fats are added than when other energy ingredients are used, and (6) fats improve overall physical appearance of feeds, allay dustiness, and contribute other physical handling and using benefits to the feed.

Table 4 presents a summary of factors considered by feed manufacturers choosing fat or other energy ingredients for making animal feeds. The cost of energy to meet feed requirements was the factor most often considered. A large number of feed manufacturers use fats at low levels because of the many other advantages. If prices of fats were lower, these firms would add more fats.

Some small mills do not have this flexibility between energy sources because they lack facilities and equipment to handle and add fats. Small mills adding fats usually buy in small quantities which often means paying a higher price per pound for their fat. This higher fat cost may be a deterrent to some small feed manufacturers to use fats. Among small feed-mixing operations not adding fat the use of expeller-type oilseed meals, meat scrap, tankage, and poultry scrap to raise the level of fat in feeds was widespread. A number of small firms reported they would start adding liquid fats if expeller meals became unavailable.

Table 3.--Factors feed manufacturers use in determining level of fat use 1/

| General determinants, and other descriptive terms used by trade | Percentage of all factors |
|---|---|
| | Percent |
| PHYSICAL | 20 |
| Improves feed appearance (Dressing; rich look; sheen) | 12 |
| Reduces dustiness (Holds down dust; size of particle) | 4 |
| Improves texture (Improves physical characteristics) | 2 |
| Improves physical properties | 2 |
| FEED VALUE | 41 |
| Energy (Raise energy level; productive energy; amount of energy to be added; calorie level) | 16 |
| Nutrition (Young animals need more fat; type of feed; calorie intake of animal; other ingredients; energy derived in specific feed; adjust fat level of feed; type of feed; recommendation of nutrionist; calorie-protein ratio) | 19 |
| Feed efficiency (Performance of feed; need good feed conversion; research findings on performance) | 6 |
| FABRICATION | 2/16 |
| Aid in pelleting (Increase production rate; ease of pelleting; nature of pellet) | 14 |
| Increase die life | 2 |
| ECONOMIC | 23 |
| Competitive pressure (Competitive practice; price vs. nutrition; recommendation of feed consultant; economics; economics of broiler production; trade demand) | 10 |
| Price (Energy value in dollars compared to corn or milo; cost; competitive cost; economy; price relation to other ingredients; greatest energy at optimum cost) | 13 |
| Grand total | 100 |

1/ Firms were not limited in the number of reasons they gave for determining level of fat use. The number varied from 0-4.
2/ Reduces dustiness is also a fabrication advantage; including this item raises fabrication subtotal to 20 percent.

Table 4.--Factors feed manufacturers use in choosing between fats and other energy ingredients 1/

| General factors, and other descriptive terms used by trade | Percentage of all factors |
|---|---|
| | Percent |
| ECONOMIC | 56 |
| Price | 48 |
| (Relative cost of meeting energy requirements; fat must be competitive with corn; cost of calories; cost of energy unit; energy value in dollars compared to corn or mill feeds; price of fat relative to corn or milo or other possible ingredients) | |
| Availability | 5 |
| (Local source) | |
| Trade demand | 3 |
| (Acceptance by trade; economy; competitive pressure) | |
| FEED VALUE | 21 |
| Type of formula | 7 |
| (Fat makes possible higher energy ration than with grain alone; can only use so much corn; overall cost of formula bulk; have to have animal fats for pet foods) | |
| Nutrition | 7 |
| (High energy; level of energy desired; content of low energy feeds such as oats) | |
| Feed efficiency | 7 |
| (Feed conversion; performance; fat improves quality of chicken; fat gets more weight on bird) | |
| PHYSICAL | 17 |
| Feed appearance | 5 |
| (Dressing) | |
| Dustiness | 4 |
| (Prevent dust; ground milo is dusty; dust control) | |
| Texture | 4 |
| (Condition of feed; gives a good texture; size of particle) | |
| Palatability | 2 |
| (Animals like fat better) | |
| Handling | 1 |
| Physical properties | 1 |
| FABRICATION | 2/ 5 |
| Production | 5 |
| (Pelleting limitations; ease of mixing; need for lubricating) | |
| OTHER REASONS | 1 |
| Advantages of using various energy feeds | 1 |
| Grand total | 100 |

1/ Firms were not limited in the number of items they gave as considerations in choosing between fats and other energy feed. The number varied from 0-4.

2/ Dustiness (4 percent) and handling (1 percent) are also factors affecting fabrication; including these raise fabrication subtotal to 10 percent.

## Kind and Quality of Fats and Oils Used

### Many Kinds of Fats Are Used in Feeds

As long as a fat is not rancid or becoming rancid, does not have an objectionable odor, is clean, has a stability of at least 20 hours (A.O.M.), and is low in moisture, it should make a satisfactory feed ingredient.

A wide range in kinds and grades of fats and oils materials is incorporated in livestock feeds. 2/ In 1960 inedible tallow and grease accounted for approximately 90 percent of all fats used. The remaining 10 percent included edible animal and vegetable fats or oils, hydrolyzed animal or vegetable fats, or mixtures of the two (sometimes called acidulated soapstocks or "foots"), ethyl or methyl esters of animal or vegetable fatty acids, 3/ fatty acids, and marine (fish) oils. The hydrolyzed fats, ethyl and methyl ester of fats, and fatty acids are either byproducts or come from byproduct materials, the supplies of which are restricted and can at best only furnish a small proportion of the fat required for use in feeds.

### Special Conditions Affecting Choice of Fats

In purchasing fats for feed making, buyers are sensitive to both price and quality. Some types of animal feeds, such as milk replacers and pet foods, require fats of especially good quality, so edible animal fats are frequently used for these purposes. Other feeds usually do not require fats of as high a quality, so lower priced "inedible" animal fats are most used. The terms "edible" and "inedible" animal fats are misnomers; the distinction is between sources and handling of animal fats suited for human consumption and other uses. It is an ethical rather than a purity standard, as applied.

Crude vegetable oils are used to some extent in mixed feeds; usually under special conditions: (1) When the size of the individual purchase is small (one drum or a few drums at a time), (2) when other, normally cheaper, fats are scarce or unavailable, or (3) when edible vegetable oils begin to go out of condition (off color) and are sold at reduced prices.

Feed manufacturers indicated they have become much more careful about the quality of the fat they use in feeds than when they first started using it. This has been brought about by their own experiences or experiences of others in the trade. A few years ago, some feed makers had a serious problem with a fat material that caused chicken edema disease, sometimes called "water belly." The toxic material was found to be contained in low-grade byproducts derived from fatty acid processing (4 p.20). Since then, the term "feed grade

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2/ For volumes of the various kinds and grades of fats and oils used in formula feeds in 1956, broken down by nine regions and three sizes of mill classifications, see Doty (6).

3/ A process has been developed by the research team of Paul H. Eaves, James J. Spadaro, and E. A. Gastrock of the Department of Agriculture's Southern Utilization Research and Development Division at New Orleans, La., to make mixed methyl esters of fatty acids directly from soapstock or "foots" and is now being used commercially.

fat" has been applied to fat products meeting quality standards for the feed trade. 4/

More care is also being exercised in the selection of tallow and grease, particularly when buying grades below No. 1 tallow or yellow grease. Many are now buying higher grade animal fats than previously. Bad experiences with fats going out of condition for feed use has caused practically all animal fats now used in feeds to be stabilized by addition of a suitable antioxidant.

## Grades of Fats Used

Inedible animal fats vary considerably in such characteristics as palatability, stability, odor, hardness (titer), free fatty acid content (F.F.A.), impurities (moisture and insoluble and unsaponifiable material, abbreviated M.I.U.), and color. The grade standards of the commonly recognized grades of inedible tallows and greases are shown in table 5.

During World War II, the Office of Price Administration issued standards for inedible tallow and grease upon which OPA prices were based. These standards were originally for the soap industry to define quality and suitability of various inedible animal fats. Following the war these standards for inedible tallow and grease were generally accepted as the trading standards of the industry.

Standards for fats for use in soapmaking do not adequately meet the needs of feed manufacturers. Color and free fatty acid content, which are important to the soap industry, have little bearing on the feed value of animal fat. The trade standards are particularly deficient, from a feed buyer's viewpoint, in that they do not measure stability, palatability (clean condition, freedom from rancidity and objectionable odors), and metabolizable energy. These are properties directly related to feeding values of the fats.

Members of the feed trade say that since the quantity of animal fats used in feeds is now near the quantity used in soap, the time has come when trade standards for inedible tallow and grease should be drawn up to meet their needs.

Nearly one-half of the feed manufacturers who add fats to feeds use the tallow and grease grade standards of the fats and oils trade exclusively in buying fats, mainly because they are the extablished basis for buying and selling animal fats. Over one-third relied upon their own tallow and grease specifications or used them in conjunction with the grade standards of the trade. This practice was followed by most of the larger feed firms. Others either relied wholly on buying from a reputable fat supplier or bought by manufacturers' brand names. Brand-name buying was most prevalent for fat products other than tallow and grease.

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4/ The Association of American Feed Control Officials in 1958 set up tentative definitions for "feed grade" fat products.

Table 5.--Characteristics of inedible grades of animal fats

| Fat | Titer 1/ (minimum) | F.F.A. 2/ (maximum) | M.I.U. 3/ (basis) | F.A.C. color 4/ maximum untreated and unbleached |
|---|---|---|---|---|
| | Degrees centigrade | Percent | Percent | |
| Tallow: | | | | |
| Fancy | 41.5 | 4 | 1 | 7 |
| Choice | 41.0 | 5 | 1 | 9 |
| Prime | 40.5 | 6 | 1 | 13 or 11B |
| Special | 40.5 | 10 | 1 | 19 or 11C |
| No. 1 | 40.5 | 15 | 2 | 33 |
| No. 3 | 40.5 | 20 | 2 | 37 |
| No. 2 | 40.0 | 35 | 2 | No color maximum |
| Grease: | | | | |
| Choice white | 37.0 | 4 | 1 | 11 |
| A, white | 37.0 | 8 | 1 | 15 |
| B, white | 36.0 | 10 | 2 | 19 or 11C |
| Yellow | 36.0 | 15 | 2 | 37 |
| House | 37.5 | 20 | 2 | 39 |
| Brown | 38.0 | 50 | 2 | No color maximum |

1/ Fats with melting point of 40° C. or higher are tallows, while those with melting points less than 40° C. are greases.

2/ Free fatty acid content.

3/ Moisture and insoluble and unsaponifiable material present.

4/ Fat analysis committee of the American Oil Chemists' Society established color standards.

Originally issued by the U. S. Office of Price Administration

## Buyers' Specifications

Individual firms' specifications for the purchase of animal tallow and grease varied widely both in the number of items covered and in the limits placed on the individual items themselves.

### Stability

The item most often covered in buyers' fat specifications was stability. In feeds, stability is a prime factor, since its effect will be evident not only in the fat itself, but in the vitamin stability of the feed with which it is mixed. Buyers' specifications usually called for a minimum stability of 20 hours A.O.M., which is equivalent to 320 days keeping time under normal storage conditions. 5/ Some specifications called for a minimum stability of 30 hours A.O.M. If rancidity develops beyond a certain level the fat becomes unpalatable, and the whole feed may become unpalatable. Oxidizing of fat in feed promotes the destruction of fat-soluble vitamins A, D, and E, which lowers the nutritional value of the feed.

Antioxidants are now used in most feed fats of animal origin. They are usually added to animal fats immediately after rendering to stabilize the fat and slow down rancidity. Antioxidants incorporated in very small amounts, less than 1 pound per ton, not only protect the fat against rancidity but help to protect vitamins against oxidative destruction. 6/ Fats of vegetable origin contain some natural antioxidants which perform those functions. The U. S. Food and Drug Administration approves antioxidants and their allowable quantities for use in feeds and vegetable fats. Meat inspection regulations of the U. S. Department of Agriculture govern the antioxidants that may be added to rendered animal fats or combinations of animal and vegetable fats and the amounts that may be used.

### Free Fatty Acid

Another widely covered item in feed firms' specifications was free fatty acid content of the fat. The maximum F. F. A. allowed in tallow and grease ranged from 3 to 15 percent. Free fatty acid content of a fat may serve as an indicator of its history and is therefore sometimes used to screen out improperly handled fats. A high free fatty acid content often has been associated with rancidity or thought to imply an inferior grade of fat. This is not true unless the high fatty acid content is a result of spoilage. A fat containing a high percentage of free fatty acids resulting from hydrolysis has a feed value equal to that of a fat low in free fatty acids (3 p.8 ). Free fatty acids do not diminish the protective action of antioxidants, as the fatty acids are stabilized by the same antioxidant that protects fat.

Free fatty acids in fats corrode some metals. Pellet dies are a particular trouble spot, and the higher the fatty acid content the greater the problem.

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5/ This is in line with the recommendations by the American Meat Institute Foundation that a feed fat should have a stability of not less than 20 hours Active Oxygen Method (A.O.M.) (2 p. 8).

6/ For additional information on adding antioxidants to fats destined for feed use see Ault and others (4 p. 5).

Die manufacturers have recently introduced anticorrosion metal dies and claim they will last twice as long as ordinary dies.

Moisture, Insoluble and Unsaponifiable Material

A third item usually covered in specifications was the amount of moisture, and of insoluble and unsaponifiable material present. The maximum M.I.U. allowed in these specifications ranged from 1 to 3 percent, some specifications contained individual allowances for moisture and unsaponifiable material.

Moisture, insoluble and unsaponifiable material in feed fat should be kept low. Low moisture content of the fat should be maintained throughout storage and handling. Citric acid is widely used in fats to improve the efficiency of the added antioxidant. Free water present in a fat will reduce or eliminate the effectiveness of the citric acid. Insolubles are a nuisance and when they become excessive they are a real problem. Heavy suspended solids in a feed fat can block screens, plug spray nozzles, and make it necessary to clean the storage tanks and other equipment more often.

Other Requirements

Often the specifications required that a fat must have a satisfactory odor. Some buyers also excluded extremely dark fats because of their darkening effect on feeds although fat color has little or no effect on feeding quality (1).

Some firms purchased only greases; this is a differentiation based on the hardness of the fat. The hardness, or titer, of the fat depends upon its fatty acid composition. Softer animal fats are known as "greases," while the harder ones are called "tallows." There is little difference chemically in these two classifications and apparently little difference nutritionally (5, p. 1195). Generally speaking, however, the harder the fat the lower the metabolizable energy value (4, p. 4).

## Other Factors Determining Choice of Fat

Feed manufacturers in selecting a fat for incorporation into formula feeds give consideration to a large number of factors. In addition to the everyday considerations, two prior considerations influence their decision: (1) The kind of feed in which the fat is to be used, and (2) whether or not their plant is equipped to handle all kinds of fats. Dog food, milk replacer, and cattle feed, for example, require a higher quality fat than poultry feed. Lower quality animal fats and vegetable oil product find their widest use in poultry feed. Many of the smaller feed manufacturers do not have adequate storage and heating facilities, which reduces their flexibility in selecting a source of fat supply. Inadequate storage facilities (less than tank car capacity) restrict their buying to small quantities, such as drums, or to local sources such as a local renderer or oil mill. Lack of proper heating facilities limits their choice to the more liquid (unsaturated) fat materials such as vegetable oil products or grease, particularly in winter.

The most often mentioned general factor used in deciding which fat to purchase was price. It accounted for almost one-third of all factors mentioned. Availability of the fat accounted for 20 percent, and these two items together made up over half of the factors mentioned by feed manufacturers in choosing a fat. Some manufacturers gave consideration only to vegetable oil materials or grease for reasons given above.

## Mechanical Incorporation of Fats into Feeds

### Mixing Fats into Feeds

Fats can be satisfactorily incorporated into formula feeds by small as well as large feed mixers, by batch as well as by continuous operations, in various capacity horizontal as well as vertical mixers, and in ground as well as pelleted feeds.

Fat can be mixed into formula feeds more easily than many other ingredients, including other liquids, because it is readily absorbed by most other feed ingredients. Usually fat is added after most other ingredients, because the other ingredients mix better (more evenly) when they are dry.

Feed manufacturers indicated they have experienced a number of problems of varying complexity in incorporating fats into feeds but by various means have been able to overcome them. The most widespread problem encountered was that of properly mixing animal fats into feeds. Animal fats have a tendency to solidify, particularly in colder weather; this causes the feed to form balls and prevents even distribution of the fat. Several solutions have been used to overcome this problem depending on operating conditions of the individual plant. These are some solutions encountered:

1. Temperature control:
   a. install fat-heating facilities
   b. heat fat to a higher temperature
   c. use jackets on barrels
   d. in electrical fat heating, use two rods instead of one
   e. change from electrical heating to steam heating
   f. use steam-heated pipelines

2. Change from tallow to a vegetable oil product or grease

3. Use liquid blenders instead of horizontal mixers.

A second problem, closely akin to the first in that it is also caused by solidification of the fat, is the clogging of pipelines and coating of equipment. In the process of incorporating fat in the feed, the fat cools, leaving a layer of material on equipment it comes in contact with, such as the mixer, mixer ribbons, pipes, and screening. This condition can be partly controlled by using fat of high enough temperature. More frequent cleaning, however, will still be required than if fat was not being used. Proportioning fat into feeds sometimes can be a problem; but this task can easily be performed by using the proper proportioning equipment now on the market.

When feeds containing added fat are pelleted the additional problem of soft pellets may be encountered, particularly when higher percentages of fat are added. This was solved in varying degrees by (1) adjusting the pelleting machinery, (2) adding fat at higher levels by spraying fat on pellets after pelleting, (3) repelleting of fines, and (4) using materials or equipment to make pellets harder.

## Cost of Mixing Feeds Containing Added Fat

Formula feed manufacturers were in general agreement that adding fats to feeds did not significantly lower the cost of mixing feeds. In order to incorporate fats into feeds some extra equipment is often required such as storage tanks equipped for heating fat, pumps, pipelines, and sprinklers. Although liquids are normally less expensive to handle than dry ingredients, fat represents another ingredient that must be added, it usually must be heated, and it lengthens feed mixing time. Most firms agreed that the lubricating effect of the added fats reduces wear on machinery and thereby saves on equipment cost. When fats are added it is easier for the manufacturer to mix certain other ingredients such as vitamins, minerals, antioxidants, and antibiotics into formula feeds. Added fat also lowers the shrinkage by decreasing the dustiness created when feeds are mixed.

Taking these factors into consideration most feed manufacturers were of the opinion that the positive and negative factors about equalled one another and, therefore, the cost of mixing feeds was about the same for feeds with and without added fat.

## Prices of Feeds Containing Added Fats

Feeds containing added fats usually were priced between 50 cents and $2 a ton more than those without added fat, depending on the level of fat. Selling prices of feeds were often based on the difference in costs per pound of fat added and the cost of the ingredients being replaced. Usually no dollar consideration was given to the advantages (physical, nutritional, fabrication, and economic) that the feeds containing added fat have over ones not containing added fat.

Some manufacturers, however, sold general-purpose feeds containing added fats at about the same price as those without fat. These firms usually took into consideration some of the advantages of adding fat, particularly those advantages more easily measured in terms of dollars and cents. It was the belief of some manufacturers that the saving on pelleting dies and equipment more than offset the difference in costs between fats and other energy feeds.

Formula feed manufacturers were in general agreement that on a calorie basis feeds containing added fat are about the same price as those without added fat. Here again, it was not a unanimous opinion, as a number of feed manufacturers said that on this basis feeds containing added fats were sold at a lower price.

## Fat Use in Pelleted Formula Feeds

A high proportion of manufacturers pelleting feeds incorporated fat, and many added fat to all of their pelleted feeds, because there are even greater advantages to adding fats to pelleted feeds than to regular feeds. Fat aids in the pelleting of feeds due to its lubricating qualities. Pelleting feeds with added fat increases the pellet production rate, reduces wear and tear on pelleting and crumbling equipment, and lengthens the life of the pellet die.

A number of feed mixers felt that added fat was now performing satisfactorily several functions previously thought of as functions of pelleting, such as dust control and the accompanying reduction in waste, improved feed appearance, increased feed conversion, and increased palatability of some feeds.

This means that formula feed manufacturers can sell some feeds as mash that were formerly pelleted. Some manufacturers felt that pellets were no longer needed for housed layers, for example. They and others said their pellet sales were down as much as 50 percent since fat addition began.

Although fat added to feeds has reduced the need for pelleting, and in some instances has substituted for it, the need for pelleting feeds to reduce bulkiness has not been eliminated. Other reasons for pelleting, in order of their frequency of mention, include: (1) Pelleted feeds, including those with added fats, have increased feed conversion; (2) pelleted feed reduces waste, particularly in range feeding and in broiler operations, because of the kind of feeders used; (3) animals eat more feed (plain or fat added) when it is pelleted, and therefore grow and gain faster; (4) some customers demand pellets; (5) pelleted feeds are easier to handle; (6) pelleting reduces costs of packaging, handling, and shipping; (7) appearance of some feeds is improved by pelleting; and (8) some high-fat rations are not eaten well unless they are pelleted.

### Percentage of Fat Added to Pellets

The fat that feed manufacturers added to pelleted feeds varied from 1/2 to 10 percent, depending on the type of feed and the reason for adding fat. Feeds with 5 to 10 percent fat were for the most part broiler finishing rations. Many manufacturers were adding from 1/2 to 2 percent fat to their general purpose feeds. Savings on dies and equipment more than offset the difference in cost between fat and other energy feeds according to some feed pelleters.

The wide range in the percentage of fat added to pelleted feeds is caused by a number of factors, which can be divided into two main groups: (1) those having to do with how much fat the feed manufacturer desires to add, and (2) those dealing with how much fat can be incorporated. This first group of factors were covered earlier in the text under the heading "Percentage of Fat Added." The second group are additional factors applicable to pelleted feed. The amount of fat that can be incorporated in pelleted feeds is governed by the need for hardness of the pellet. A soft pellet resulting from too much added fat may break or crumble too easily. Manufacturers held widely divergent views on the maximum amount of fat that could be added prior to pelleting and still produce a satisfactory pellet. Their answers varied widely from firm to firm,

ranging from 1 to 6 percent added fat. Part of this difference is due to the variation in the ingredients of feeds pelleted. It also points up the great differences that exist between feed mills both in technology and in plant operations. Over three-fourths of these feed manufacturers felt the maximum fat that could be added before pelleting and still produce a satisfactory pellet was between 2 and 5 percent, with more firms stating 3 percent than any other level. The highest percentage of fat that can be added and still produce a satisfactory pellet (using the same type of equipment) depends on the absorptive capacity of the feed and the method of fat application.

## Absorptive Capacity

The ability of a particular feed to absorb fat depends upon its ingredients. Corn, for example, has a low absorption rate, while bran has a high one. A feed high in fiber content usually has a high absorptive capacity; moisture and fat in the feed usually restrict the amount of fat that can be absorbed. Fat absorptive capacity also depends on the texture of the feed, the size of the pellets, and the temperature of the fat being incorporated. Hot fat is more readily absorbed than cold fat, and usually the smaller the particle the better it can be absorbed. Other added ingredients also affect the fat-absorbing quality of the final feed.

## Method of Application

Another factor affecting the amount of fat that can be added to pellets is the method of fat application. Usually fat is added prior to pelleting if the amount being incorporated is 5 percent or less. It is possible to incorporate much more fat by adding some fat prior to pelleting and spraying the remaining hot fat on after the pellets have been broken into bite-size pieces. For example, a manufacturer desiring to add 8 percent fat to a pelleted feed might incorporate 3 percent fat before pelleting and then apply the remaining 5 percent to the feed after it is pelleted. A number of manufacturers thought that pelleted feeds containing as much as 10 percent added fat could be produced if the fat was incorporated in this manner.

## Effect of Added Fats on Pelleting Dies and Crumbling Machinery

Feed manufacturers generally took the viewpoint that fat added to feeds reduced wear on pelleting dies. A majority of firms thought die life was increased between 10 and 15 percent. Some firms' estimates of die life were several times higher than these figures. Dies usually cost between $300 and $500, depending on the size. A 10-percent increase in die life means that under a particular set of conditions a die will last 2 to 3 months longer. Therefore, longer lasting dies can be a rather significant item to feed manufacturers who pellet their product. Feed manufacturers felt that pellets containing added fat were easier to crumble and that crumbling machinery lasted longer when pellets contained added fats. Estimates by the relatively few who indicated how much longer crumbling machinery might last when added fats were used ranged from 5 to 25 percent longer.

Adding fats to pelleted feeds often means a softer pellet. Because of this characteristic there are more fines, which necessitates running more

material through the pelleting operation a second time. This lessens somewhat the production advantages of adding fats to pelleted feeds.

## FACTORS AFFECTING ADDITION OF FATS AND OILS TO ALFALFA MEAL

### Basic Developments

Fat has found a market in alfalfa meal production mainly because of its dust-settling properties. Alfalfa meal manufacturers had an acute dust problem for many years, both in the conduct of their own operations and in satisfying their customers (manufacturers of formula feeds) who like a product that is fairly free from dust. In the last decade, pelleting and adding some fat have practically eliminated the dust problem.

Alfalfa is artificially dried (dehydrated) or sun cured to produce meal. The meal may be pelleted and reground to reduce volume, make handling easier, and give a wider range of alfalfa meal products. The dehydrated alfalfa industry has increased its production more than 400 percent in the last 15 years. Current domestic production is slightly over 1 million tons a year, a large portion of which is used in poultry feeds. It is anticipated that dehydrated alfalfa production will continue to increase but at a slower rate. This leveling off has been apparent the past few years. On the other hand production of sun-cured alfalfa during this period has dropped more than 50 percent to about 200,000 tons. Dehydrated alfalfa retains more of its nutrients, has better color, and is more uniform than natural sun-dried alfalfa. These are some reasons for the expected continued growth of the dehydrated alfalfa industry (9).

### Alfalfa Meal As A Market For Fats

Indications are that fat is being added to almost half of the alfalfa meal produced. The use of fats to control dustiness during processing and handling stood out as being far more important than any other reason for adding fats to alfalfa meal. Other reasons given for adding fats to alfalfa meal were improved appearance, increased energy value, a carrier for antioxidants, customers' specifications, and competition. Another advantage is a reduction in the explosion and fire hazards associated with dust.

Alfalfa meal manufacturers adding fat to some but not to all of their production gave two reasons for this practice: (1) There is not enough demand for fat-added meal; and (2) some buyers are not willing to pay the additional cost. Alfalfa meal with added fat usually sells at a premium over regular meal because on a per pound basis fat sells for 2 to 3 times as much as alfalfa meal. Firms not adding an antioxidant to their alfalfa meal would need to perform another operation to incorporate fat. Alfalfa meal manufacturers not adding fat to their production either lacked fat-handling facilities and equipment or looked upon fat addition as inconvenient.

### Choice of Fats

The kind and quality of fats incorporated into alfalfa meal vary widely. For dust control, animal fats were considered superior to most vegetable oil

materials because they are more slowly absorbed by the meal which means dust control lasts longer. Of those adding graded animal fats the majority were found to be adding greases; yellow grease was the most widely used and also the lowest grade employed.

Alfalfa meal is considered a good source of carotene for livestock. Carotene (vitamin A) is destroyed by oxidation and a stabilized fat protects the carotene. Therefore, all animal fats used were stabilized.

### Percentage of Fat Added

There was a difference of opinion between firms as to whether 1 or 2 percent fat should be added to dehydrated alfalfa meal for optimum dust-control benefits. There was general agreement that sun-cured alfalfa meal was dustier than dehydrated alfalfa meal and consequently needed more fat added to it. The amount of fat actually being added to alfalfa meal varied from 1/2 to 3 percent, with most firms adding either 1 or 2 percent.

### Effect of Fat on Need for Pelleting Alfalfa Meal

Alfalfa meal manufacturers were unanimous in their opinion that adding fat to alfalfa meal did not eliminate the need for pelleting. The main reason they gave for pelleting alfalfa meal was to reduce its bulkiness, which makes it easier to handle. Pelleting does reduce the need for added fat by controlling to some extent the dustiness of alfalfa meal.

## Factors Affecting Future Use of Fats in Alfalfa Meal

### Blenders

Blenders are large distributors and marketers of alfalfa meal products. They use meal or pellets from dehydrators to make blends that have standard quality and, usually, a high percentage of added fat. In the last few years a number of the small manufacturers of dehydrated alfalfa meal have become affiliated with or incorporated into organizations having a blending operation. This change in operating practices in the dehydrated alfalfa meal industry has affected the market for fats in recent years. It will probably have a greater effect in the future. When the individual dehydrators made and marketed meal, some added fat and some did not. They usually used vegetable oil products bought by the drum. Blenders, on the other hand, with their larger operations, are equipped to add animal fats. They buy animal fats in tank cars, add it to more of their alfalfa meal and add a higher percentage of fat than individual dehydrators did when they performed this function.

### Bulk Handling

Alfalfa meal manufacturers are adopting more bulk handling methods. This should increase the rise of fat since there is a greater need to control dust

when bulk handling methods are used. The increase in the use of fat could result from a more widespread application of fat and the incorporation of fats at higher percentage levels. At present, however, the situation is not clear-cut in favor of more fat; alfalfa meal manufacturers may switch to bulk handling but, instead of shipping alfalfa meal or reground pellets, they might ship the meal in whole pellet form to formula feed manufacturers who might or might not add the fat in their feed mixing operations.

### Antioxidants

The primary purpose of adding antioxidants to alfalfa meal is to stablize the vitamin A content of the meal so as to prevent the rapid loss of this important vitamin. The Food and Drug Administration has recently approved the use of a specific antioxidant for incorporation in alfalfa meal. 7/ The use of antioxidants for this purpose will not have the impact they would have had several years ago because in recent years much inert gas storage has been built. The oxidizable nutrients in alfalfa meal are preserved when stored under these conditions, thus eliminating to some extent the need for an antioxidant. Alfalfa meal manufacturers stated that at present a number of feed manufacturers specifically request that the alfalfa meal they purchase not contain an antioxidant.

If antioxidants become widely employed in alfalfa meal there would be an increase in the total quantity of fats added to the meal. Fats are an ideal carrier for antioxidants and simplify their incorporation into alfalfa meal. However, a new water soluable form of the antioxidant could be used instead. Alfalfa meal manufacturers stated that when an antioxidant for stabilizing vitamin A is added, fat is usually added at about the 1-percent level. Conceivably it might be desirable to add antioxidants to all alfalfa meal, including that kept under inert storage conditions, because antioxidants could be added at the point of production to prevent vitamin A loss between field and the inert storage facility and would give an added protection to preservation of quality. Protection would also be given to the product after it is withdrawn from storage for use in mixed feeds. Those manufacturers previously adding 1 percent fat or more to their alfalfa meal would not add additional fat if they decided to add an antioxidant. However, if the addition of antioxidants to stabilize vitamin A became widely used, much of the alfalfa meal presently not containing added fat (over 50 percent of the total alfalfa meal production) would then contain at least 1 percent added fat.

## FACTORS AFFECTING ADDITION OF FATS AND OILS TO OILSEED MEALS

There has been a decided increase in the use of the solvent method for extracting oils from oilseeds in recent years. Solvent extraction methods remove more oil than other extraction methods, leaving the resulting meals dry and dusty.

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7/ Ethoxyquin (1-2 dihydro, 6 ethoxy, 2-2-4 trimethylquinoline), developed by the U. S. Department of Agriculture and sold under the trade name of Santoquin.

The processor using solvent extraction has several alternatives for handling meals: (1) leave more of the oil in the meal; this is seldom practiced because much of the advantage of solvent extraction would be lost, (2) add some less expensive oil or fat product to the meal, or (3) market the meal as is and let the feed manufacturer decide what to do about the dustiness and the oil content of the finished formula feed.

## Soybeans

In 1957-58 solvent extraction accounted for 93 percent of the soybeans processed (8). The high percentage of soybeans processed by the solvent extraction method results in a fairly standardized meal of low fat content which is used as the main basis for trading. Usually no fat is added to soybean meal produced by any process because the trade doesn't demand it. When extractors do add fat to soybean meal it is usually done to bring the oil content up to minimum requirements of State regulations. It does not appear likely that additional fats or oils will be added to much soybean meal in the future.

## Cottonseed

Of the cottonseed processed in 1957-58, the screw-press method accounted for 58 percent; hydraulic press method, 13 percent; and solvent method, including prepress operations, 29 percent (8).

Fat is seldom added to either screw-press or hydraulic-press cottonseed meal, which usually contains 4 to 5 percent fat. However, part of the solvent-extracted cottonseed meal is brought back up to the 2- or 3-percent fat level. Many companies add fat to all the cottonseed meal they produce by solvent extraction. Some other companies add fat to meet customers' specifications which vary from 1 to 3 percent. The reason usually given for this addition is dust control--not energy. There is a greater dust problem with cottonseed meal than with soybean meal. In addition there may be some resistance in the trade to low-fat solvent process meal because of the availability of large quantities of higher fat content cottonseed meals processed by other methods.

The fat added to solvent-extracted cottonseed meal is mostly hydrolyzed vegetable oil product (acidulated soapstocks or acidulated foots). This gives oil refiners a convenient outlet for this byproduct. Because this fatty material is hydrolyzed the trade considers it fairly stable; antioxidants are usually not added. It is expected that solvent extraction will account for a higher proportion of cottonseed processing as plants are remodeled or new plants are built. This should constitute a larger market for fats as it is expected that fatty material will continue to be added to solvent-extracted cottonseed meal.

## Other Oilseed Meals

Meals from several other oil-bearing materials are used as feed for livestock. The more important of these meals are linseed, safflower, copra, and peanut. Fat is often added to meals resulting from solvent extraction methods

but rarely to meals produced by the other extraction methods. This is largely due to trade resistance to low-fat solvent-extracted meals. The fat product added is usually a hydrolyzed vegetable oil product not stabilized by the addition of antioxidants.

## POTENTIAL USE OF FAT IN FEEDS AND FEED INGREDIENTS

Growth in use of fats in feeds from the present level of 500 million pounds to 1.4 billion pounds over the next decade does not appear unreasonable. If a market of this magnitude were realized it would relieve most of the pressure on domestic tallow and grease producers caused by their increased production and inability to move the product into domestic consumption.

The figure of 1.4 billion pounds was arrived at by multiplying 1958 feed production (Census) times the fat percentage most widely added to each type of mixed feed and feed ingredient as determined by the survey. The percentage estimate was based on the frequency of use by feed manufacturers in the sample, weighted by the volume of feed to which it was added. It excludes consideration of various practices of the livestock feeding industry found in the survey that indicate an even higher consumption may be realized.

Census data, which according to their definition include about 80 percent of total mixed feed production, were used rather than an estimate of the total mixed feed production because the Census figures give a more detailed breakdown of the various types of feeds and because the segment of the mixed feed industry on which the Census report is based is most likely to add fats. 8/ No attempt was made to project the estimated production of each type of feed for some future year. It is anticipated, however, that prepared animal feed production will continue to increase in years to come due to increased production of poultry and livestock and the desire of farmers to feed farm animals more scientifically. Thus the feed industry's capacity to absorb fat could increase above the level indicated.

There is a trend toward adding fats to commercially made feed-mixing ingredients as well as toward adding fats in the mixture for the final feed. Therefore, it was necessary to estimate fats consumption by both feed ingredient suppliers and feed mixers. If the trend toward adding fats to feed ingredients continues, some feed mills might find it unnecessary to add fats to certain types of mixed feeds in the future. Some feed mills today are not adding more fat and others are not using a separate fat ingredient because they are able to buy expeller soybean oil meal or other oilseed meals containing approximately 5 percent fat, or meat scraps, tankage, and poultry byproduct meal containing 8 to 15 percent fat. Another possibility for the future is that cooked unextracted soybeans may become available for some feed mixers to use advantageously

8/ The Bureau of the Census reports include shipments of commercially prepared feeds from establishments engaged primarily in the production of livestock and poultry feeds. Substantial quantities of mixed feeds are produced in establishments not included in these reports. Not included are feeds manufactured in grain elevators, custom or grist mills, farm supply stores, chicken hatcheries, commercial broiler, hog, and cattle feeding operations on farms, and byproduct feeds sold for direct consumption as such.

as a feed ingredient. This could also eliminate the need of adding fats to certain mixed feeds.

The relative cost of fats and oils and other sources of energy is an important factor affecting the potential market of fats as a feed ingredient. Market expansion for fats in feeds depends largely, for high-level use, upon the price of fats.

Productive energy of tallow is approximately 2.6 times that of cornmeal (7, p. 6). Table 6 shows corn prices per bushel and the price of that quantity of tallow having the same productive energy (11).

During the period 1956-60 feed manufacturers did not vary their quarterly use of fats according to changing price relationships between corn and fats. The price of tallow was relatively higher than corn, based on productive energy as a feed, for most of the 5-year period. The rapid expansion in the use of fats in feeds during this period shows that feed mixers have found it worthwhile to pay a premium for fats. This premium has been as high as 34 percent for a quarter-year period. However, the use of fats in feeds so far has mainly been at low concentration levels and the price of fat becomes more important when it is employed at higher levels.

## Major Reasons for Increased Use of Fats in Feeds

A number of factors found to exist in the feed manufacturing industry and in livestock feeding practices indicate the estimated future use of 1.4 billion pounds of fat in feeds is attainable. The following are some of these reasons:

1. There is a trend toward increased production of livestock and poultry by farmers. Additional feed will be required to produce these animals. An increase in the amount of prepared animal feeds produced means additional use of fats.

2. There is a trend toward increased use of formula feeds by farmers. As livestock are fed more scientifically, a greater number of ingredients performing various functions are contained in formula feeds. An increase in the use of formula feeds means additional use of fats.

3. There is a trend toward increased pelleting in the feed industry. There are more advantages in adding fats to pelleted than to mash type feeds; therefore, fats are widely added to pelleted feeds and in larger quantities than in most other types of feeds. An increase in pelleting means additional use of fats.

4. There is a trend in the feed industry toward more bulk handling of feeds. The addition of fat helps control the dust problem of handling bulk feeds and also cuts down on feed loss. An increase in bulk handling of feeds means additional use of fats.

5. Prices of tallow and of grease are not likely to advance much in the near future and probably will remain relatively stable. Greater domestic livestock production and slaughter will increase tallow and grease production.

Table 6.--Costs of tallow and ground corn on the same productive energy basis, and fats and oils used in formula feeds

| Year and quarter | Tallow: Price per pound 1/ | Tallow: Prices on a corn energy per bushel basis 2/ | Ground corn, price per bushel 3/ | Tallow price as a percentage of corn price | Fats and oils used in formula feeds 4/ |
|---|---|---|---|---|---|
| | Cents | Dollars | Dollars | Percent | Million pounds |
| 1956 | | | | | |
| Jan.-Mar... | 6.8 | 1.46 | 1.39 | 105 | 69.3 |
| Apr.-June.. | 6.7 | 1.44 | 1.61 | 89 | 80.9 |
| July-Sept.. | 6.4 | 1.38 | 1.67 | 83 | 87.3 |
| Oct.-Dec... | 6.9 | 1.49 | 1.44 | 103 | 88.6 |
| Total.... | | | | | 326.1 |
| 1957 | | | | | |
| Jan.-Mar... | 6.8 | 1.46 | 1.41 | 104 | 104.5 |
| Apr.-June.. | 7.0 | 1.51 | 1.41 | 107 | 112.2 |
| July-Sept.. | 7.8 | 1.68 | 1.39 | 121 | 114.7 |
| Oct.-Dec... | 8.0 | 1.72 | 1.28 | 134 | 130.5 |
| Total | | | | | 461.9 |
| 1958 | | | | | |
| Jan.-Mar... | 7.6 | 1.64 | 1.24 | 132 | 144.9 |
| Apr.-June.. | 7.4 | 1.59 | 1.42 | 112 | 151.6 |
| July-Sept.. | 7.5 | 1.62 | 1.41 | 115 | 150.0 |
| Oct.-Dec... | 7.5 | 1.62 | 1.25 | 130 | 143.3 |
| Total.... | | | | | 589.8 |
| 1959 | | | | | |
| Jan.-Mar... | 7.0 | 1.51 | 1.28 | 118 | 118.4 |
| Apr.-June.. | 6.8 | 1.46 | 1.30 | 112 | 131.7 |
| July-Sept.. | 6.2 | 1.34 | 1.33 | 101 | 119.7 |
| Oct.-Dec... | 5.9 | 1.27 | 1.21 | 105 | 111.5 |
| Total.... | | | | | 481.3 |
| 1960 | | | | | |
| Jan.-Mar.. | 5.4 | 1.16 | 1.25 | 93 | 120.9 |
| Apr.-June.. | 5.7 | 1.23 | 1.30 | 95 | 130.2 |
| July-Sept.. | 5.5 | 1.18 | 1.27 | 93 | 129.5 |
| Oct.-Dec... | 5.6 | 1.21 | 1.12 | 108 | 123.3 |
| Total.... | | | | | 503.9 |

1/ Inedible tallow prime, tanks, Chicago.
2/ Productive energy of tallow is approximately 2.6 times that of cornmeal.
3/ No. 2 yellow corn, Chicago. Includes an allowance of 8 cents for grinding charge.
4/ Bureau of the Census.

Also, we depend on foreign markets for disposal of over 40 percent of our present production. The outlook, therefore, is for ample supplies of tallow and grease with their prices continuing to favor use in feeds.

6. There is a trend toward shortening the feeding period for livestock destined for slaughter by feeding high-protein, high-energy rations. In this type of ration the high-energy part can only be supplied by fat.

7. It has been demonstrated that chicks have improved growth and feed conversion even when fed very high levels of fat (over 30 percent) (10). Until recently it was thought that chicks' tolerance for fats was quite low--less than half this level was considered by many to be the maximum. An increase in percentage level of fat in poultry feeds means additional use of fats.

8. There is a trend toward using more fats in feeds of other animals. Current research has tested and recommended higher levels of fat than are employed commercially today. The addition of more fat to other animal feeds has in many instances been found to be advantageous. Further research may indicate even higher levels of added fat can be used to an advantage. An increase in the use of added fats in these other animal feeds means additional use of fats.

9. An increasing number of advantages have been discovered for adding fats to feeds. Some of these are better handling (less dust), improved appearance, better nutrition, increased feed efficiency, added growth responses especially with vegetable oils, promotes absorption of fat-soluble vitamins and calcium, and reduced mixing and pelleting costs. Because of these and other advantages feed mixers have found it worthwhile to pay a premium for fats above their value as a supplier of productive energy. Recognition of the large number of advantages for adding fats by more feed mixers and livestock feeders will encourage greater use of fats in feeds.

10. There is a trend toward increased use of the solvent-extraction method for processing various oilseeds. Solvent-extracted meals contain considerably less fat (usually 3 to 5 percent less) than oilseed meals extracted by other processes. As older methods of fat extraction are discarded and solvent extraction becomes more important additional fat will be used. Fat will be added either by oilseed processors directly to the meal or by formula feed manufacturers in the production of their feed products.

11. Antioxidants have recently been approved by Food and Drug Administration for use in alfalfa meal. Fats are an excellent carrier for adding antioxidants to alfalfa meal. If the addition of antioxidants to alfalfa meal becomes a widespread practice then additional fats will be used by the alfalfa meal industry.

12. New methods and equipment are making it possible for small feed manufacturers and individual farmers (livestock feeders) to add fats to the feeds they produce with less difficulty (14, 15). As it becomes more practical for small feed manufacturers and livestock farmers to add fats to their feeds, additional fat will be used.

## Need for Research

There are still many questions that need to be answered in the field of use of fats in feeds. The following is not intended to be a complete list of research needs but is presented to indicate some of the areas where additional research work is called for:

1. A need exists to make dry or grandular fats so fats can be added to feeds by the large number of feedmixers presently not equiped to use liquid fats. This product is also needed so that fats can be added to feeds at higher levels than are presently employed and avoid the fat leakage and gumming problems. Spray drying is a possibility but an even better solution might be to react fat with starch or sugar to tie up the fat and prevent leakage.

2. Find better ways of handling, adding, and mixing fats into feeds, especially for small mills.

3. Search for means of producing satisfactory pellets when using levels of fat higher than presently employed.

4. Determine the optimum level of fat addition to rations for different kinds of animals at various protein levels in mixed feeds having a large variety of feed ingredients.

5. Develop methods to determine and to measure the toxicity factors in fat products used in feeds so as to prevent reoccurrence of such diseases as chicken edema.

6. Work needs to be done so that when conditions are favorable whole oilseeds, such as soybeans, may be used in mixed feeds. They would fit particularly well in the high-fat, high-protein feeds.

7. Study the influence of dietary fats on carcass quality of animals. Studies in this area should consider various kinds of added fat used at varying levels, rations with various ingredients fed to different kinds of animals.

8. Investigate the use of additional modified fats or fatty acid derivatives of various types in feeds for even better results than now obtained from the feeding of unmodified fats.

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