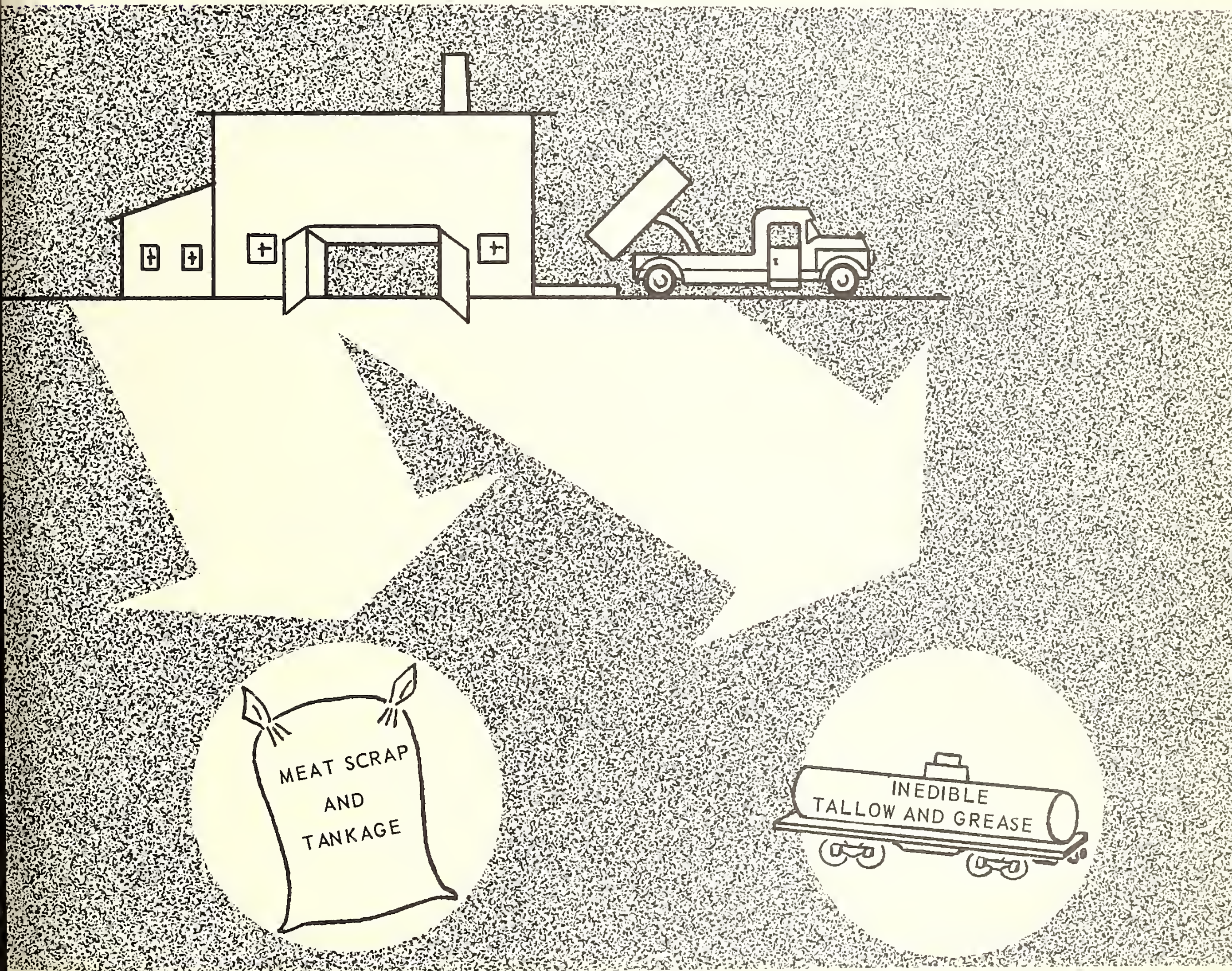
RENDERING INEDIBLE ANIMAL FATS

Analysis of Practices in Pennsylvania and Minnesota



Marketing Research Report No. 283

Agricultural Marketing Service
Marketing Research Division

UNITED STATES DEPARTMENT OF AGRICULTURE

PREFACE

This report concerns the practices of renderers of inedible animal fats in Pennsylvania and Minnesota. It describes the collection, production, and marketing of these fats in 1956.

This study is a phase of the research being conducted on the marketing of inedible animal fats and oils and is part of a broad program being conducted by the United States Department of Agriculture to help improve the marketing of primary agricultural products.

Widespread interest by producers and users of animal fats and oils prompted this study. It is directed toward those engaged in the production of inedible tallow and greases and to others who may wish to engage in further research on animal fats.

Thompson, John William, 1931–
Rendering inedible animal fats; analysis of practices in Pennsylvania and Minnesota. [Washington, U. S. Govt. Print. Off., 1958]

vi, 61 p. illus., tables. 26 cm. (U. S. Dept. of Agriculture. Marketing research report no. 283)

Cover title.
Bibliography: p. 59.

1. Oils and fats. [1. Fats and oils—Processing] I. Title. (Series)

HD1751.A9183 no. 283 665.2 Agr 58-310

U. S. Dept. of Agr. Libr. 1Ag84Mr no. 283
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ACKNOWLEDGMENTS

Acknowledgment is made, as follows:

For permission to use certain reference material: University of Chicago, American Meat Institute Foundation, and American Meat Institute, Chicago, Ill.; Stanford University, Stanford, Calif.; Meat Merchandising, Inc., St. Louis, Mo.; Proctor and Gamble, Cincinnati, Ohio; The National Provisioner, and Meat (publication), Chicago, Ill.

For cooperation in the survey: The National Renderers Association and the renderers and slaughterers located in Pennsylvania and Minnesota who furnished the basic data for this study.

For assistance in overall planning and developing of the personal interview schedule, Donald Jackson, Marketing Research Division, Agricultural Marketing Service. For help in identifying the various segments of the industry and describing the different chemical measurements as they are related to quality, W. C. Ault, Eastern Utilization Research and Development Division, Agricultural Research Service.

November 1958

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. -

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SUMMARY

More complete recovery of animal byproducts such as hides, blood, glands, edible fats, and inedible fats has been made in recent years, thereby giving the farmer greater returns from his livestock. From the animal byproducts are rendered inedible tallow and greases which had a national wholesale value of approximately $200 million in 1956. Pennsylvania and Minnesota inedible tallow and grease had a value of $11 million. Inedible tallow and greases are used mainly in soap manufacture and in fat splitting, and in recent years about 12 percent of the total domestic consumption has been added to livestock feed.

This report describes the collection of raw materials, the production, and the marketing of tankage and inedible tallow and grease in Pennsylvania and Minnesota, 1956. The main findings are:

1. The renderers and slaughterers of Pennsylvania and Minnesota cooperating in this study produced 175 million pounds of inedible animal fats in 1956. This was 5.6 percent of the total United States production.

2. Approximately 98 percent of the inedible tallow and grease was produced by the dry reduction method and almost all of the resulting tankage was used as livestock feed.

3. Many rendering plants are basically manual operations and mechanization is needed. The estimated capital required for the basic equipment, land, and building for an average-size new rendering establishment is estimated at $76 thousand.

4. The cost of raw material is a renderer's greatest expense, and the cost of collecting raw material is a renderer's second largest expense.

5. A renderer usually needs an operating margin of 1 to 2 cents per pound on all raw material to cover hauling, processing, and profit.

6. Improvements in transportation and competition for raw material have caused renderers to increase the size of their collection areas. In some instances uneconomical collection practices have arisen because of this increase.

7. Only 44 percent of the renderers and 36 percent of the slaughterers in Pennsylvania and Minnesota made an attempt to separate dark and light fats before cooking.

8. Only 7 percent of the renderers and 64 percent of the slaughterers in Pennsylvania and Minnesota washed raw material before cooking.

9. Rendering operations varied greatly as to temperature, agitator speed, length of cooking, and percent of moisture left in the tankage when cooking was done.

10. Storage facilities for fats were generally inadequate. Many renderers and slaughterers could store only 10 to 12 percent of their annual production making it necessary to sell their fat every 4 to 6 weeks regardless of the market price.

11. Twelve percent of the renderers and 33 percent of the slaughterers storing fat in bulk in Pennsylvania and Minnesota had only one storage tank and could not store light and dark fats separately.

12. Very few plants had facilities for determining the grade of fat produced.

13. Labor requirements per ton of fat and tankage produced varied from approximately 3 to 30 man-hours.

14. In most of the rendering operations the production process was basically a manual operation. Raw material was fed through the grinder and into the cookers by hand and the percolator pans were emptied by shoveling the tankage into presses.

A significant difference in the type and size of plants was observed in the two States. Most of the Pennsylvania renderers collected raw material in metropolitan areas; they collected mainly fat, bones, and grease. Minnesota renderers collected mainly in rural areas, picking up mostly fallen or dead animals. Pennsylvania renderers had larger plants and better facilities for marketing their animal fats. Minnesota renderers, located in an important livestock producing State, had an advantage in the marketing of their meat scrap and tankage.

Some of the following recommendations are applicable to most rendering plants and are directed toward greater returns through more efficient operations and production of higher quality products.

1. Change the routing of collection trucks when new accounts are opened or old ones closed, and reorganize collection routes so that some trucks will reach the plant at different intervals during the day.

2. Haul raw material in bulk when possible.

3. Separate light and dark fats before cooking.

4. Wash paunches and dirty material, and cook all material as quickly as possible the same day it is collected.

5. Hold the last material cooked in the cookers overnight so the plant crew can unload and press the next morning.

6. Use split shifts so that only a few personnel are necessary in the morning before the raw material arrives at the plant.

7. Know the weight and yield of fat and tankage from raw materials as well as processing, collection, and marketing costs in order to better determine the price that can be paid for raw material.

8. Have adequate storage facilities so it will not be necessary to sell fat regardless of the market price.

9. Invest in the materials and equipment for analyzing the color, moisture, and free fatty acid content of the fat produced and in storage.

10. Install conveyors to move raw materials to the hasher and cooker and tankage to the grinder and storage bins, if feasible.

The results of the present study indicate that additional research in the following areas may be helpful to the industry:

1. The optimum time, temperature, and agitator speed required to produce a high quality of fat and tankage from different raw materials.

2. The effect of varying moisture content in unpressed tankage on the cost of pressing operations and grades of fat and tankage produced.

3. The relationship of different labor-capital and equipment combinations to the economic efficiency of extracting fat from tankage by the screw, hydraulic, or solvent method.

4. The effect of distance hauled, volume collected, and yield of fat and tankage on the price renderers pay for raw materials.

RENDERING INEDIBLE ANIMAL FATS

Analysis of Practices in Pennsylvania and Minnesota

By John W. Thompson, agricultural economist
Marketing Research Division, Agricultural Marketing Service

OBJECTIVES, METHODS, AND PROCEDURES

The objective of this analysis of current practices in procuring, processing, and marketing in the inedible rendering industry was to provide information of assistance to the industry in improving its practices. Four important characteristics in the inedible rendering industry gave rise to the need for this study.

First, the number of plants rendering inedible animal wastes has decreased at least 9 percent since 1947, while production of inedible animal fats has been increasing. Most of this change has occurred through the consolidation of two or more small rendering plants into one large plant with increased capacity and efficiency.

Statistics for the postwar period also indicate that some slaughterers discontinued rendering, as they preferred to sell their offals to renderers. In 1947, slaughterers and packers rendered 55 percent of the animal fats by value. By 1954 this had almost reversed and renderers were producing 54 percent of the total production. 1/

Second, the industry as a whole has been slow to adopt mechanization. Characteristically, rendering has grown from a primitive process and expanded spasmodically as the production of inedible animal fats increased. Many plants are too small or lack capital to add the machinery necessary for mechanization and production of a quality product. Antiquated equipment, practices, and methods of rendering need revamping in order to produce quality products efficiently.

Third, a high quality and grade of inedible tallow and grease are needed for export and domestic use in order to expand markets, and create new products. Only in recent years has any attempt been made to produce high quality and uniform grades of inedible animal fats.

Fourth, the price of inedible tallow and grease has fluctuated greatly, reaching a high of 26.6 cents per pound for tallow in March 1947 and a low of

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1/ United States Bureau of the Census. Census of Manufactures Bulletin MC-28G; 20 pp., p. 14. 1954.

3.6 cents per pound in June 1953 (3, p. 213). 2/ New uses and new markets should help to control these price fluctuations so that neither producer nor consumer would be subject to extremely high or low prices. An additional benefit that could arise from the increased efficiency of renderers is greater returns to the farmer from livestock byproducts.

This report describes some inefficiencies in these rendering plants and attempts to determine the most efficient practices the industry can employ to help achieve its objectives.

In this study attention has been directed toward all renderers producing inedible tallow and grease and slaughterers rendering inedible fats. "Lard renderers" and "edible renderers" are not covered in this report and should not be confused with renderers of inedible animal fats.

Primary data were collected by personal interview from March to June 1957 through the cooperation of 47 renderers and 30 slaughterers in Pennsylvania and 24 renderers and 4 slaughterers in Minnesota. During these visits marketing researchers discussed problems with plant managers and owners, reviewed plant records and data, and observed plant operations.

In addition, they talked to brokers, exporters, soap manufacturers, and other users of animal byproducts to develop an understanding of the marketing of animal fats and feeds. Secondary data available from the Bureau of the Census, trade publications, Department of Agriculture marketing research reports, and other sources, are also used.

GENERAL CHARACTERISTICS OF THE INDUSTRY

Type and Size of Plants

The typical rendering operation represented by 75 percent of the plants rendering inedible wastes contacted in Pennsylvania and Minnesota had for basic plant equipment 2 cookers, 1 hydraulic or screw press, and a boiler to generate steam. Auxiliary equipment included a hog or hasher to grind bones, a percolator pan to drain the tankage of free grease, a settling tank, 1 or 2 storage tanks for fat, a grinder or hammermill for meat scrap and tankage, and a conveyor. 3/ While renderers and slaughterers both had the same basic equipment, renderers tended to have more of the auxiliary equipment. A flow diagram of raw material through a rendering plant is shown in figure 1. The average inedible rendering operation had 3 to 4 plant employees, produced 785,000 pounds of animal fat, and 770 tons of meat scrap or tankage a year. For renderers with this size operation, it was necessary to employ 3 to 4 truck drivers who generally collected raw material within a 35-mile radius of the plant.

2/ Underscored figures in parentheses refer to items in bibliography, p. 59.

3/ See glossary of terms at end of report.

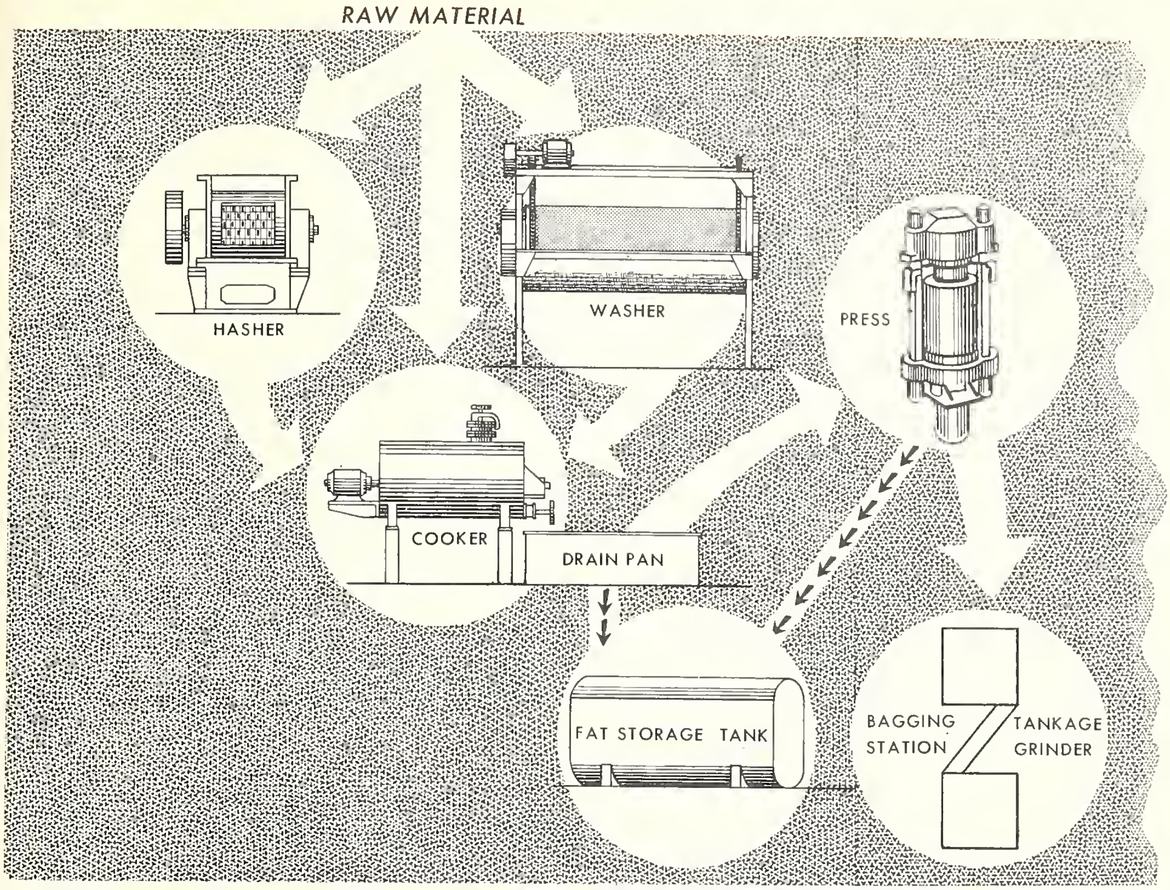

Figure 1. Flow Diagram of Raw Material through Rendering Plant

Location

Many rendering plants were originally built outside city limits and away from dwellings, but urbanization has brought residences in proximity to plants creating a pressure for control of odors or moving of plants from populated areas. In the survey for this study 68 percent of the Pennsylvania renderers were located in rural areas and 87 percent of the Minnesota renderers were located in rural areas in 1956 (table 1). Some renderers located in rural areas collected the major portion of their raw material in metropolitan areas. Only 18 percent of the slaughterers in both States operated in rural areas.

For many years the rendering industry was characterized as an objectionable operation. Offensive odors, stream pollution, and unsanitary practices tended to give the industry a poor reputation. Since the advent of dry rendering in 1920 and modern sanitary practices, the industry has made tremendous strides toward the elimination of objectionable odors, inadequate methods of water and manure disposal, and poor collection practices which have been associated with rendering. Over 71 percent of the plants visited had condensers, and 26 percent used an antioxidant all or part of the time in the "cook" to reduce offensive odors. Most of the plants visited had an adequate form of water and manure disposal and a general degree of cleanliness prevailed.

Table 1.--Type of ownership and location of rendering and slaughtering plants in 2 States, 1957

Type of plant and State	Type of ownership 1/			Location 2/	
	Corporations and cooperatives	Individual proprietorship	Partnership	Urban	Rural
	Number	Number	Number	Number	Number
Renderers:					
Pennsylvania	19	8	10	15	32
Minnesota	11	3	5	3	21
Slaughterers:					
Pennsylvania and Minnesota	24	6	4	28	6

1/ Ownership may include more than one plant. All renderers and slaughterers did not report type of ownership.
2/ A plant in a rural location had no more than one home located within one-fourth mile radius of the plant.

Usually the same labor force was used during the summer months, although production was lower, to move the raw material to and within the plant faster and keep the plant clean. Many plants are washed down daily with steam, and the trucks for collection are kept clean.

Consolidation

The number of establishments rendering inedible animal fats in the United States was 500 in 1954. 4/ This did not include slaughterers. Several small rendering plants are being consolidated into one plant to gain advantages such as economies from a larger operation; the next industry census will undoubtedly show fewer plants. Several slaughterers in Pennsylvania in 1956 found it more advantageous to discontinue their rendering operations and sell their raw material. Improved highways and modern transportation have made it possible for raw materials to be transported longer distances. Due in part to the large amount of capital necessary to start a rendering operation, it appears from discussions with plant managers that corporations are replacing the partnership and individual (or family-owned) rendering plants (table 1). It appears that a consolidation of rendering plants will continue as the capital requirements necessary for an economic-sized plant continue to increase.

4/ United States Bureau of the Census. 1954. Census of Manufactures Bulletin MC-28G; 20 pp., p. 5. Based on Bureau of Census classification, a rendering plant derives over half of its income from the sale of inedible fats.

Manual vs. Mechanized Operations

Rendering inedible animal offals in most plants visited is basically a manual operation. In over half of the plants visited in this study, raw materials were fed through a hog (see Glossary) into the cookers by hand. It was necessary in most of the plants to shovel tankage from the percolator pans into the presses. Pressed tankage was transported to the storage bins by carts or wheelbarrows when a conveyor could have been used.

Very little research has been directed toward improving the machinery used in rendering plants. The screw presses or expellers in use were originally built to extract vegetable fats, not animal fats. New machinery (such as prebreakers, screw conveyors, blow tanks, automatic percolators, and end-point control mechanisms) has been slow to gain acceptance. Complete automation of rendering does not yet exist, but it is not beyond current technology. Mechanization must precede automation, and many rendering plants have ample opportunity to use machinery to reduce the labor force and produce a uniform product. The following suggestions offer a guide toward mechanization of rendering plants. 5/

1. Improve working conditions with better lighting, housekeeping, and ventilation.

2. Improve plant layout to reduce lost motion and needless handling.

3. Increase utilization of existing equipment.

4. Improve present operations with methods requiring a relatively small capital investment.

In 1956 one renderer who invested $100,000 in modernizing his plant was able to reduce the labor force by 18 men and lower the daily operating hours of the plant from 24 to 16 without reducing quantity of material handled. Along with this saving of manpower, it was possible to produce and maintain a uniform quality of fat (8). Expenditures such as this are necessary and justifiable if the rendering industry is to offset the rising production costs by increasing production per man-hour.

Capital Requirements

The estimated fixed capital for a rendering plant varies greatly depending on the size of plant. For a small 2-cooker plant, such as those visited, capable of producing 1 million pounds of animal fat a year, $76,000 is estimated to be the fixed capital requirement. 6/ This is about the same as that

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5/ Scott, Gerald L. Automation Rendering. A paper presented to the National Renderers Association Convention, pp. 8-9. 1957.
6/ Kahle, H. S. Processing Poultry Byproducts in Poultry Slaughtering Plants. U. S. Dept. Agr. Mktg. Res. Rpt. No. 181, 77 pp., illus. 1957.

required for a small poultry byproduct rendering plant. Other items, such as conveyors, office equipment, filter press, hasher, washer, or trucks, are not included in this estimate of fixed capital requirements. The capital necessary to purchase an established rendering plant will vary greatly, depending partly upon the amount of raw material available in the area. Some plants visited for this study had a small capital investment. These plants were located in old buildings; the plant operators purchased used machinery, or built much of it themselves.

Below are itemized estimates of fixed capital for a small 2-cooker plant with a press (data from table D-16, Mktg. Res. Rpt. 181, p. 68, U. S. Dept. Agr., June 1957):

2 - 4 x 7 cookers, with 25-hp. motor each	$13,340	
1 - Screw press, 500 lb. per hour	5,200	
1 - Hammermill, 0.5 ton per hour, with 15-hp. motor	1,230	
1 - Boiler, 70 BHP	7,400	
1 - Water softener	300	
2 - Condensers with hot well	2,000	
1 - Bag scale and bag stitcher	1,200	
Fat storage tanks	1,150	
1 - Fat pump	250	
1 - Magnetic separator	100	
1 - Cyclone	200	
1 - Truck scale	1,000	
Total equipment cost		$33,370
Installation, 40 percent		13,400
Water well	3,000	
Land, 0.5 acre	500	
Building, 1,800 square feet	10,800	
		14,300
Physical plant cost	61,070	
Contractor's fee and contingency		15,300
Fixed capital		$76,370

RAW MATERIAL PROCUREMENT

Volume

Modern transportation facilities have made it possible for the renderer to follow more thorough collection practices over a larger area which also has enabled volume increases. In 1908 the prices paid per pound for raw materials were: Suet fat, 4.5 cents; rough fat, 2.5 cents; bones, 0.75 cent. The finished product (tallow) sold for 6.5 cents a pound (9). Today about the same price spread of 2 to 4 cents a pound prevails between suet fat and rough fat and finished products. In order to operate with the same margin today as in 1908, most renderers have increased their volume to lower their processing costs per ton. While in many instances this has given the renderer a sufficient operating margin, rising costs of labor may make it necessary for him to invest capital for modern and efficient plants.

Greater collections have resulted in more raw material for the renderer of inedible products. While the total weight of commercial livestock slaughter has increased about 22 percent from 1946 to 1956, production of inedible tallow and grease increased 90 percent during this period. This increased production of inedible animal fats can be attributed in part to more inedible raw materials being trimmed from the livestock carcasses but to a greater extent on a more thorough collection of raw materials from all sources by the inedible renderer. As the slaughterer and packer have tended to specialize in the production and marketing of meats, the renderer has become more specialized in the collection, production, and marketing of inedible tallow and greases.

Most renderers reported a yearly increase in raw material collected since 1940. They attributed this increase to: Slaughterers discontinuing rendering, collection of poultry offal, increased trimmings from retail meat stores, and collection of raw materials in rural areas not previously served. The Census of Manufactures indicates the production of inedible animal fats by renderers increased 74 percent per plant or from 165,000 pounds to 287,000 pounds from 1947 to 1954. 7/

Pricing

Most renderers pay for raw material before the actual cost of production and value of the finished products are known. This can be to their advantage or disadvantage. For example, the renderer may pay 4 cents per pound for raw suet fat based on 8 cents per pound for finished tallow. When this tallow is sold 1 to 2 months after the purchase of raw material, the value of tallow may be only 6 cents per pound. Thus, the renderer in this case paid too high a price for raw material. The same may apply to increased operating and production costs within the plant. In other instances, the renderer may have an advantage when the market for tallow and grease rises following his purchase of raw material.

In recent years some renderers have developed a working agreement with meat markets, slaughterers, or other sellers of raw material to pay for raw material according to the market value of inedible tallow and grease. A formula using a fixed operating margin, based on the yield of fat and tankage from the raw material, helps the renderer avoid a possible economic disadvantage through market price fluctuations, provided the following are correctly determined and considered:

7/ United States Bureau of the Census. 1954 Census of Manufactures Bul. MC-28G; 20 pp., pp. 5, 14.

1. Distance raw material hauled.
2. Volume of raw material.
3. Correct yield of fat and tankage.
4. Proper weighing of raw material.
5. Proper separation of fat, bones, or suet by the seller.

A typical formula, which can vary greatly, for suet fat and bones follows. This formula is used to determine prices to be paid by renderers and is based on the value of the finished products--bleachable fancy tallow 8 cents per pound and tankage (50-percent protein) 4 cents per pound.

	Cents per pound
A. Value of Suet Fat	
1. 75 percent of 8-cent-per-pound finished tallow value	6.0
2. 10 percent of 4-cent-per-pound finished tankage value	.4
Total	6.4
3. Deduct 1-2 cents for hauling, processing, and profit	1/ 2.0
Value of suet fat	4.4
B. Value of Bones	
1. 15 percent of 8-cent-per-pound finished tallow value	1.2
2. 50 percent of 4-cent-per pound finished tankage value	2.0
Total	3.2
3. Deduct 1-2 cents per pound for hauling, processing, and profit	1/ 2.0
Value of raw bones	1.2

1/ Higher value used.

When a renderer and a seller of raw material can work out such an agreement, both may benefit. The seller receives a value for his raw material based on the market value of animal fat and tankage and bears the risk of market fluctuations. The renderer, however, still has the risk of finding a buyer for the fat and tankage and the risk of changing plant operating margins.

There is a great variation in the price paid by the renderer for the same kind of raw material. If a renderer can collect one ton of fresh clean bones from a slaughterer every day, this slaughterer warrants a higher price than a small slaughterer or butcher who has only 300 pounds of bones for sale two or three times a week. The distance hauled, amount collected, quality of material, and type of material have a great effect on the price paid for raw material by most renderers. In table 2 are shown the low, high, and average prices of

Table 2.--Range and average price per pound paid for raw materials collected by renderers, by type of materials purchased, Pennsylvania and Minnesota, spring 1957

RURAL

Raw material	Pennsylvania			Minnesota		
	Low	High	Average	Low	High	Average
	Cents	Cents	Cents	Cents	Cents	Cents
Suet fat	2.0	5.0	3.4	---	---	---
Shop fat	1.0	3.3	2.2	---	---	---
Mixed fat	1.5	4.0	2.8	0.50	2.9	1.6
Bones	.3	2.0	.9	.42	1.5	.8
Kitchen grease	1.0	4.0	2.8	.02	2.0	1.2

URBAN 1/

Raw material	Pennsylvania			Minnesota			Average wholesale price paid 2/
	Low	High	Average	Low	High	Average	
	Cents	Cents	Cents	Cents	Cents	Cents	Cents
Suet fat	3.0	6.0	4.1	2.5	3.5	2.7	2.8
Shop fat	1.5	4.8	2.5	1.5	2.5	1.7	1.6
Mixed fat	---	---	---	---	---	---	---
Bones	.2	1.5	.6	.5	1.0	.9	---
Kitchen grease	.8	4.0	2.4	1.5	3.0	2.0	---

1/ Cities of over 1,000,000 population.
2/ Taken from Butchers Advocate, March 15, 1957 to June 15, 1957 issues.

different raw materials. Urban renderers in Minnesota paid higher average prices for raw material than did rural renderers. Pennsylvania urban renderers paid more than rural renderers for all raw material except for bones and kitchen grease. Most of this difference in price was related to the distance the material was hauled and the volume collected. A renderer whose truck expense and driver's wage cost 10 cents per minute and who stops 6 minutes to pick up only 100 pounds of bones cannot afford to pay much for the bones. If the renderer paid $2.00 per hundredweight for the bones and the cost for transportation was 60 cents, the value of fat and tankage would not cover the costs of production.

Sources

The commercially available supply of raw materials for the production of inedible tallow and greases comes from a number of heterogeneous sources. Roughly, they fall into 6 classes: (1) Slaughterhouse and locker plant byproducts, including animals dying enroute to slaugher or condemned at slaughter; (2) shop fats, suet, trimmings, and bones from retail butchers, meat markets, and grocers; (3) similar materials with used or spent fats from hotels, restaurants, and institutions; (4) fallen animals (see Glossary); (5) poultry offals; and (6) miscellaneous matter.

The source of raw material for the slaughterer is generally his own operation; his practice of collecting raw material from the retail butcher shops is diminishing. All the renderers in this study reported the complete collection of fat-yielding raw material in their area of collection except for two small areas in Pennsylvania where fallen animals were not collected. Table 3 shows what percentage each of the different raw materials collected by renderers was of the total supply.

Table 3.--Types of raw materials collected in rural and metropolitan areas by renderers of Pennsylvania and Minnesota, 1956, shown as a percentage of the total collected

Class and State	Renderers reporting	All fat	Bones	Offal	Kitchen grease	Fallen animals	Other 1/	Total
	No.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Rural:								
Pennsylvania ...	8	25	36	11	10	10	8	100
Minnesota	12	4	11	13	1	55	16	100
Metropolitan: 2/								
Pennsylvania ...	5	48	39	8	5	--	--	100
Minnesota	4	23	36	6	2	20	13	100

1/ Poultry byproducts and miscellaneous matter from furriers, glue factories, hide tanners, and fish canners.
2/ Metropolitan renderers are classified as those who collect less than 1,200 fallen cattle per year, or less than 10 percent of their total fat production is dependent on fallen animals.

Slaughterhouse and Locker Plant Byproducts

The byproducts from slaughtering operations provide the largest source of raw material supply for the rendering of animal fats. Renderers purchase a large amount of their raw materials from slaughterers, and the apparent trend is for slaughterers to sell their raw material to renderers, thus decreasing the amount of rendering done by slaughterers. Those slaughterers in Pennsylvania and Minnesota who reported for this study had a yield of inedible tallow from cattle of 39.6 pounds per head and a yield of inedible grease from hogs of 6.3 pounds per head.

Bones from the increased sale of boneless meats represent a new supply of raw material for the production of inedible tallow and grease. These bones, which yield about 15 percent tallow, have generally been thrown into garbage by the housewife, but as more boneless meat is sold the recovery of additional animal waste is possible.

In most instances where slaughterers sold their byproducts to renderers the fat, bones, and offal (such as guts, paunches, and windpipes) were kept separated. The renderer generally made daily collection of the raw material, paying for the bones and fat but not for the offal, since the yield of fat from offal is low. In some instances, where a large volume was sold by the slaughterers, $\frac{1}{4}$ cent a pound was paid for offal. A few slaughterers who did not separate the fat, bones, and offal sold their raw material by the "head" of livestock slaughtered. The reported price varied from $1.00 to $1.50 per head.

Retail Meat Trade

The second largest volume of raw material is suet, shop fat, and bones from butchers, grocers, and meat markets. Good suet, such as kidney or caul, is about 75 percent pure tallow. Shop fat from the various meat trimmings contains about 50 percent pure tallow (depending on the moisture). Renderers regard these high-yielding fats as the most desirable type of raw material.

Beef and mutton fats predominate over hog fats because of the different practices in dressing the carcasses of these animals. Almost all the fat trimmed from hogs is rendered into lard. It is a trade custom to ship carcasses of cattle in sides or quarters and calves, sheep, and lambs in whole carcasses. This results in 20 to 30 percent visible fat and 10 to 15 percent bones to be removed by the retail meat trade. The price paid per pound for this material in 1956 varied according to the volume, distance from renderers, and the yield of tallow or grease (table 2). The approximate yield of inedible fat and tankage from bones, shop fat, and suet fat is shown in table 4.

Hotel, Restaurant, and Institution

Fat rendered from raw material obtained from hotels, restaurants, and other institutions generally is of a low grade, and is known as kitchen, house, or brown grease. The raw material collected from these sources is heterogeneous and mainly composed of used shortenings, greases, cooking fats, and other wastes from the preparation and consumption of food. Renderers also may obtain the bones remaining after the edible portion of meat is eaten and the meat

Table 4.--Yield of inedible fats and tankage from fallen animals and retail meat trade wastes as a percent of total weight of raw material rendered by dry reduction method 1/

Product	Pressed tankage	Grease	Tallow	Lard
	Percent	Percent	Percent	Percent
Dead animals and shop scrap:				
Bones and dead animals	28-30	---	8-10	---
Shop fats	18.0	---	50.0	---
Suet	7.0	---	75.0	---
Average	29.5	20.5	---	---
Bones	50.6	13.6	---	---

1/ Adapted from Inedible Animal Fats in the United States. L. B. Zapoleon. Fats and Oils Studies, 1929. Appendix table V-A, page 319.

trimmings and trap grease from "interceptors" or catch basins. In many instances this heterogeneous material is not separated, and, due to the poor quality of grease resulting, does not have much value. Table 2 shows the average price paid for kitchen grease.

Fallen Animals

Before 1940, fallen animals were the primary source of inedible animal fat. Today fallen animals account for a small percentage of the total fat production and most metropolitan renderers do not collect any fallen animals. The decline in dead stock as a primary source of raw material is attributable to fewer fallen animals, a low return of fat, difficulties in handling, high cost of collection, and low value of the hides.

The practice in some parts of the United States to charge for the collection of dead stock has been increasing. Minnesota reports indicated that no renderer charged for the collection of dead stock, but in Pennsylvania a few renderers who did not generally collect fallen animals charged up to $5.00 per animal collected, depending on the size. This practice of charging was generally done where the number of such animals was small and the collection costs were high.

Under other circumstances 6 renderers of Pennsylvania and Minnesota paid $1.50 to $3.00 for dead cattle. This practice was feasible owing to the large volume of dead animals and low collection costs. Stockyards, large institutions, or extensive livestock slaughtering areas were principal sources. The expected yield of inedible fat and tankage for fallen animals is shown in table 4.

In two small areas of Pennsylvania dead stock were not collected by renderers at the time the survey was made, and many dead animals on the ranges of the West are not collected.

Poultry Byproducts

Poultry byproducts have brought about an increasing supply of raw material for the rendering industry (6). Prior to 1950, most of the feathers, offal, and blood from poultry slaughtering plants were discarded. The relatively narrow margins predominating in the poultry industry created an interest in reclaiming byproducts to give additional returns to the poultry industry. The recent trend toward complete evisceration of poultry has intensified the problem of byproduct utilization and the recovery of poultry wastes. It can represent to the poultry slaughterer an added source of income if the byproducts are recovered or an expense if they create a disposal problem.

Renderers are the principal outlet for poultry byproducts and received offal from more than half the poultry slaughtering plants in 1955. The growing recovery of poultry byproducts is providing a large volume of raw material for renderers.

Proximity of the renderer to a poultry slaughterer and the volume available are important factors in determining what, if any, price the renderer will pay for raw poultry offal. In the study of poultry byproducts and waste, about one-third of the eviscerating plants reported receiving payment for offal (6). About two-thirds of the poultry plants slaughtering 100,000 or more pounds per week received a payment for offal, whereas less than one-fifth of the plants of smaller size mentioned receiving payment.

Prices received for offal by poultry slaughtering plants, 1955, were as follows (data from Mktg. Res. Rpt. 143, table 7, p. 20, U. S. Dept. Agr., Nov. 1956):

Cents per cwt.	Number of plants reporting
0 - 24	28
25 - 49	55
50 - 74	28
75 and over (sales to fur farmers)	11
Total	122

In contrast, slaughterers who have offal removed to town dumps or municipal incinerators pay the disposal costs. These costs, as reported by some plants, ranged from about 12 to 30 cents per hundredweight.

Renderers prefer to collect offal and byproducts from large slaughtering plants so they can minimize their assembly costs. Slaughtering plants which operate on a seasonal basis often find it difficult to establish satisfactory working relationships with renderers since the large volume received over a short period of time is difficult for the renderer to handle efficiently and economically.

The volume of rendering material available from a poultry slaughtering plant can be estimated. The dried blood, feather meal, poultry byproduct meal, and grease will equal roughly 10 percent of the live weight of the poultry slaughtered. Actual yields will vary considerably, depending upon the kind and class of poultry, the finish of the birds, and handling practices. The amounts of poultry offal collected by renderers reporting for this study are included under the heading "other" in table 3.

Miscellaneous Matter

Furriers, glue factories, hide tanners, fish canners, and various industries account for a small amount of raw material available for rendering. Several renderers reported collection of raw material from these industries, but the small volume available made these sources of minor importance to the renderers. The raw material from these sources was included under "other" in table 3.

Collection

Method of Hauling

Modern transportation facilities have had a great effect in the consolidation of rendering operations, and growth of the rendering industry, by making it possible to collect raw material from many sources over a large area.

For most renderers the collection of raw material represents the largest expenditure other than cost of raw material in the operation of a rendering plant. Not only are the wages paid to drivers higher than wages received by plant men, but the high cost of truck operation and maintenance makes this item of foremost concern to most renderers. There is a wide variation in collection costs among renderers and often within the same rendering operation, owing to the type of material collected, the size and age of trucks used, and metropolitan or rural collections. The data collected for this study were not directly concerned with collection costs; however, two studies (1, p. 28; 12, p. 38) indicate that a $1\frac{1}{2}$- to $2\frac{1}{2}$-ton stake-body truck such as most renderers use costs 17 to 23 cents per mile for the fixed and operating expenses. A breakdown of expenses for trucks delivering produce in a metropolitan area in 1954 can be seen in tables 5 and 6. Additional research on this phase of rendering is needed.

The following practices have been successful for some renderers in facilitating efficient collection practices and lowering costs:

Table 5.--Summary of nonlabor variable and fixed expenses of wholesaler's delivery trucks, December 1, 1953-November 30, 1954

	Year of manufacture	Distance traveled	Variable expenses						Fixed expenses						Total expenses	
			Gasoline and oil	Tires	Repairs and parts	Miscellaneous servicing	Total variable expenses	Variable expenses per vehicle mile	Depreciation	Insurance	Licenses and taxes	Interest	Total fixed expenses	Fixed expenses per vehicle mile	Total variable and fixed expenses	Variable and fixed expenses per vehicle mile
		Miles	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Straight truck:																
Number 10	1948	4,520	213.10	110.02	200.17	9.80	533.09	0.1179	1/	253.12	50.00	1/	303.12	0.0671	836.21	0.1850
Number 11	1954	8,038	309.20	75.19	109.16	15.80	509.35	.0634	935.50	325.30	64.19	76.47	1,401.46	.1744	1,910.81	.2377
Number 12	1950	8,520	343.00	142.94	296.92	13.80	796.66	.0935	582.29	264.12	61.90	64.98	973.29	.1142	1,769.95	.2077
Number 16	1952	17,308	411.22	211.48	207.41	17.80	847.91	.0490	557.28	274.72	61.40	62.48	955.88	.0552	1,803.79	.1042
Number 17	1948	6,004	290.70	198.36	478.58	10.25	977.89	.1629	1/	254.12	33.00	1/	287.12	.0478	1,265.01	.2107
Number 20	1950	13,940	485.50	208.90	365.84	16.70	1,076.94	.0773	833.00	290.12	151.91	101.30	1,376.33	.0987	2,453.27	.1760
Total or average		58,330	2,052.72	946.89	1,658.08	84.15	4,741.84	.0813	2,908.07	1,661.50	422.40	305.23	5,297.20	.0908	10,039.04	.1721

1/ These vehicles are fully depreciated.

Reproduced from Marketing Research Report No. 127, table 20, page 38. U. S. Dept. Agr., June 1956.

Table 6.--Gasoline and oil expense of wholesaler's delivery trucks, December 1, 1953-November 30, 1954

Item	Year of manufacture	Amount of gasoline used	Distance traveled	Distance per gallon	Gasoline expense	Amount of oil used	Oil expense	Total gasoline and oil expense	Gasoline and oil expense per vehicle mile
		Gallons	Miles	Miles	Dollars	Quarts	Dollars	Dollars	Dollars
Straight truck:									
Number 10	1948	850.7	4,520	5.3	199.06	72	14.04	213.10	0.0471
Number 11	1954	1,215.5	8,038	6.6	284.43	127	24.77	309.20	.0385
Number 12	1950	1,405.8	8,520	6.1	328.96	72	14.04	343.00	.0403
Number 16	1952	1,636.5	17,308	10.6	382.94	145	28.28	411.22	.0238
Number 17	1948	1,208.1	6,004	5.0	282.70	41	8.00	290.70	.0484
Number 20	1950	1,980.6	13,940	7.0	463.46	113	22.04	485.50	.0348
Total or average		8,297.2	58,330	7.0	1,941.55	570	111.17	2,052.72	.0352

Reproduced from Marketing Research Report No. 127, table 12, page 25. U. S. Dept. Agr., June 1956.

Standardization of trucks
Maintaining a service and repair shop
Field representative for customer relations
A training period for drivers
Systematic truck routing
Detailed cost accounting systems
Bulk collection of raw material
Radio-equipped trucks
Uniform method of payment of raw material accounts

Slaughterers who do rendering have a distinct advantage over the renderer concerning the collection of raw material. The slaughterers' supply of raw material is transported from the killing floor to the cooker and the high costs of collection are avoided.

Equipment

The type of truck generally used by renderers for the collection of raw material is a straight truck of $1\frac{1}{2}$- to $2\frac{1}{2}$-ton capacity. In a few instances some large renderers used truck tractors and semitrailers where the volume of raw material and distance hauled warranted it. Several rural renderers had smaller trucks for the collection of dead stock. These smaller trucks, being more maneuverable, saved time and were less costly to operate when only a few fallen animals were collected daily. Almost all renderers who collected dead stock had a winch of some type mounted on the truck to pull large animals onto the truck. Some were hand operated, but usually a motor driven type of winch was used.

For the collection of city fat, many of the trucks were equipped with hydraulic tailgates, to lift raw material to the truck bed. Hydraulic tailgates were needed, especially when full barrels of raw material were collected from pickup points that had no loading platforms.

Fat, bones, offal, and kitchen grease are generally hauled to the rendering plant in barrels or similar containers. The chief advantage of this method is that the material is kept separated, unloading at the plant requires no special equipment, and the material can be held in the barrels until the cooker is ready to be charged--freeing the truck for additional collections. The greatest disadvantage of this method is the expense and time involved in cleaning the barrels.

In Pennsylvania and Minnesota, in 1956, 62 renderers hauled raw material in containers, 8 hauled raw material in bulk only, 57 furnished containers, and 5 did not furnish containers.

Bulk hauling is gradually replacing barrels. The equipment needed for bulk hauling includes tight truck beds, an unloading pit, a hydraulic hoist to raise the truck or truck bed, and facilities to hold the raw material until it is charged into the cooker. The chief advantages of bulk hauling are ease of loading and unloading the truck, lower labor cost in collection, and elimination of cleaning and maintenance of barrels.

Practices and Costs

A renderer must continually balance the cost of collection against volume of material collected. The major factors affecting collection costs are: Labor and truck expense per mile; time required for each pickup; amount collected at each stop; distance from the plant; and the yield of tallow, grease, and tankage from the raw material collected.

The location of a rendering plant affects the method of collection and type of raw material collected. Metropolitan renderers have an advantage over rural renderers in collection practices. The metropolitan renderer needed fewer trucks for collection of raw material when measured by pounds of fat produced mainly because he collects higher yielding fats. Table 7 shows that as production increases, the area of collection and number of collections generally increase. The use of trucks to collect the larger volume of raw material does not increase in proportion to the increased production of fat. Metropolitan renderers producing between 1.0 and 1.9 million pounds of fat a year used on the average 4.4 trucks for collection, whereas a rural renderer producing the same amount needed 7 trucks on the average.

Pennsylvania and Minnesota renderers traveled about the same radius from the plant (table 8). However, Pennsylbania renderers had a considerable amount of overlap in their collection of raw material. Twenty-two Minnesota renderers covered 80,000 square miles and 40 Pennsylvania renderers covered 45,000 square miles. This overlap of collection areas by Pennsylvania renderers results in higher collection costs. It appears that Pennsylvania renderers could have lowered their collection costs by concentrating on the collection of raw material in their own area.

In collecting a large number of fallen animals it was necessary for most Minnesota renderers to use one additional truck (per million pounds of fat rendered). Fallen animals tripled the weight of raw material hauled by Minnesota renderers but the yield of fat from the dead stock was small. The fixed and operating cost of the additional truck by the Minnesota renderer could be partly overcome by lower wages paid to employees and a large source of raw material (fallen animals) was free. However, most renderers collecting fallen animals need some additional labor at the plant to skin and process the animals.

Several renderers in Pennsylvania reported discontinuing the collection of fallen animals in 1956, because of increased wages, truck operating costs, and high inplant handling costs per fallen animal.

Generally, the renderer of inedible fats in an effort to gain adequate returns has tried to increase the volume of raw material collected to lower the plant costs per ton of material processed. A renderer, however, should

Table 7.--Average number of trucks, furthest radius from plant, and number of collections of raw material by volume of output for 38 rural and 24 metropolitan renderers in Pennsylvania and Minnesota, 1956 1/

Renderers by volume of tallow and grease (million pounds)	Renderers reporting	Trucks used 2/	Furthest radius from plant	Collections 3/
	Number	Number	Miles	Number
Rural renderers:				
Under 1.0	18	3.0	39	29
1.0 - 1.9	15	7.1	69	127
2.0 and over	5	7.0	67	358
Metropolitan renderers:				
Under 1.0	3	2.4	32	55
1.0 - 1.9	6	4.4	47	132
2.0 - 3.9	9	6.4	107	322
4.0 - 7.9	3	12.7	88	701
8.0 and over	3	23.0	112	966

1/ Metropolitan renderers are classified as ones who collect less than 1,200 fallen cattle per year or less than 10 percent of their total fat production is dependent on fallen animals.
2/ Includes dead stock trucks.
3/ Does not include dead stock collections.

carefully consider the additional trucks, drivers, and miles traveled before increasing his area of collection. Also, it is important to keep in mind that as the miles' radius from the plant goes up arithmetically, the area covered increases geometrically. Under these circumstances a renderer who keeps his collection area small can make two or three trips a day with each truck to the plant while a renderer covering a large area can make only one trip a day to the plant.

Metropolitan and Rural Renderers

The average rural renderer in Pennsylvania and Minnesota produced 1 million pounds of fat per year and the average metropolitan renderers produced 3.9 million pounds of fat per year (figs. 2 and 3). The metropolitan renderer, producing almost 4 times as much fat per year, went 26 miles further from the plant and used 3 more trucks than the rural renderer. Even where the volume of raw material collected by rural and metropolitan renderers is the same, the metropolitan renderers are apt to get a higher yield of fat than the rural renderers, owing to the type of raw material collected.

Table 8.--Average number of trucks, area covered, and number of collections of raw material by volume of output for Pennsylvania and Minnesota renderers, 1956

Renderers by volume of tallow and grease per year (million pounds)	Renderers reporting	Trucks used 1/	Furthest radius from plant	Number of "city fat" collections 2/
	Number	Number	Miles	Number
Pennsylvania:				
Under 1.0	14	2.8	34	13
1.0 - 1.9	12	4.5	55	31
2.0 - 3.9	8	7.5	57	57
Over 4.0	6	17.4	83	217
Minnesota:				
Under 1.0	7	3.1	39	9
1.0 - 1.9	9	6.5	61	24
Over 2.0	6	7.5	80	107

1/ Includes dead stock trucks.
2/ Does not include dead stock collections.

Many rural renderers felt they could not afford the truck operating cost when fallen animals were over 50 miles from the plant.

Metropolitan renderers producing under 2 million pounds of fat a year did not use as many trucks or drive as far to collect raw material as did rural renderers. Producing over 2 million pounds of fat per year made it necessary for the metropolitan renderer to collect raw material over a larger area and to increase the number of city fat collections in proportion to his production. The number of trucks used by the metropolitan renderer increases proportionally as production of fat increases (table 7).

Independent Collectors and Contract Haulers

Seventeen renderers in Minnesota and Pennsylvania had a small part of their raw material supplied by independent collectors or contract haulers. In Pennsylvania the "independent" collectors had no affiliation with the rendering plant and the plant had no control over their area of collection. These independent collectors were not consistent in their delivery of raw material, being free to sell their raw material to the renderer paying the highest price. In Minnesota 4 renderers hired contract haulers to deliver raw material to the plant. The renderer was in contact with the seller of raw material and told the contract hauler where to pick up the raw material. These contract haulers agreed in

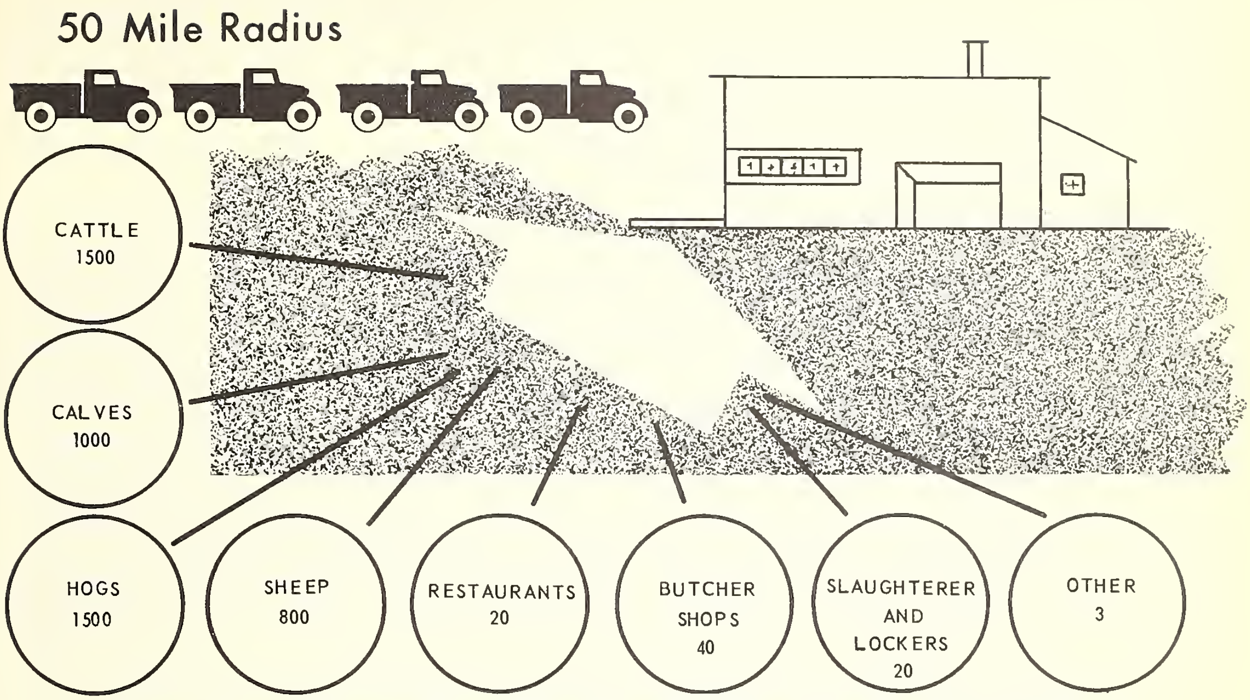

Figure 2 Sources of material, number of trucks, and radius covered from plant by a typical rural renderer in Pennsylvania and Minnesota producing 1 million pounds of inedible tallow and grease, 1956.

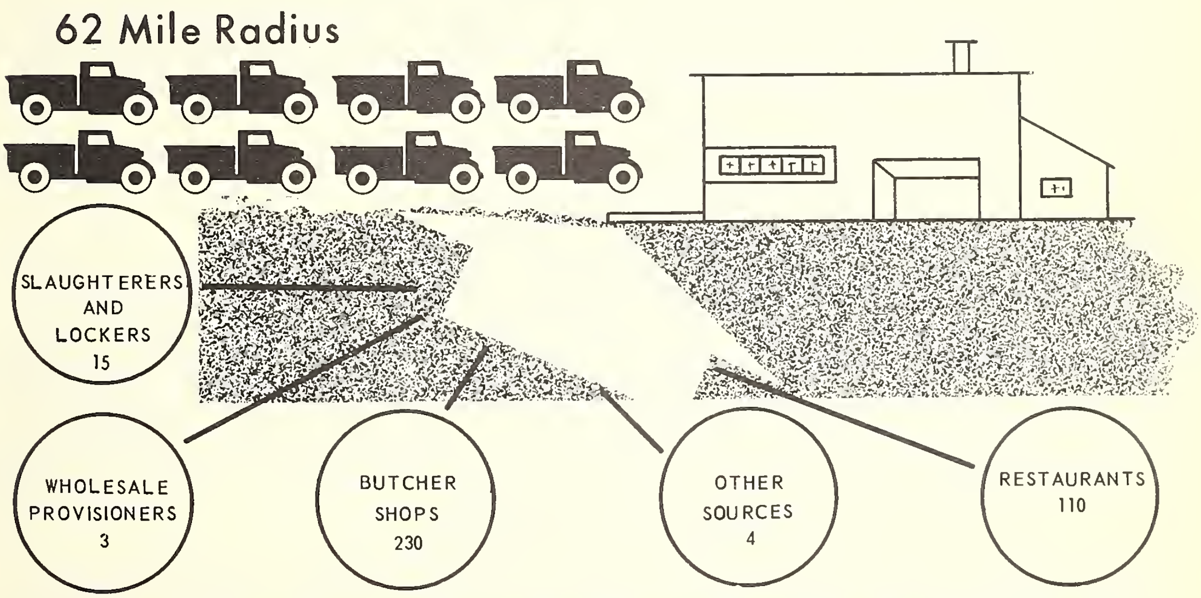

Figure 3 Sources of material, number of trucks, and radius covered from plant by a typical metropolitan renderer in Pennsylvania and Minnesota producing 3.9 million pounds of inedible tallow and grease, 1956.

writing to collect the raw material and deliver it to the rendering plant. The operators' returns varied with the weight of raw material delivered. Some renderers were against the use of contract haulers while others showed interest in having all their hauling done under contract. By paying drivers only for tonnage received, the buyer may minimize problems connected with long working hours and costs of employee benefits.

Trip Routing

The planning and scheduling of routes is an important factor overlooked by many renderers. If the routing of pickup collections were left to the discretion of the drivers, many times the driver would arrange the routes so that certain restaurants or his home made a convenient stopping place during the day.

It can be assumed that the routing of trucks by most renderers could be improved to save time and expense. As new collection accounts are added or others dropped, the routing needs to be changed. Some large renderers find it necessary to employ personnel to change and reroute the trucks daily. The easiest method used by a renderer to facilitate the correct routing and scheduling is to maintain a large map and by the use of pins for each collection point, route the trucks in the most efficient manner.

A somewhat different problem of routing, but one of equal importance, concerns the large amount of overtime accumulated by drivers in rural collections. Many renderers reported paying a small hourly wage to rural drivers or fallen animal collectors, but paying them a higher rate of overtime which gave the drivers a minimum wage ranging from $55 to $95 a week. This method was used where drivers collected fallen animals in the evening or weekends. When this practice is followed, management has an added supervisory job of being sure such payments are justified.

Payment for Raw Material

Large renderers generally paid for raw material by check once a month, while many small renderers paid cash for the material as it was collected. Renderers preferred to pay by check but some sellers demanded cash payment. Paying cash placed an added responsibility on the drivers, and it appears that bonding of the drivers may be advisable in some cases. When the number of accounts warranted it, a billing machine was used to facilitate payment.

Weighing of Raw Material

Almost all trucks used by the renderers for collecting raw material carried scales; however, many times the material was weighed on the scales of the seller. In a few cases the weight of the material was estimated by the collector.

Generally, large renderers weighed the loaded truck when it arrived at the plant, while many small renderers did not weigh any material when it reached the plant. The weighing of material at the plant periodically, if not continually, helps in determining if the correct weight was credited to the seller.

PLANT OPERATIONS

The operations necessary to separate fat from the raw material appear to be similar in all rendering plants. In actual practice, however, these seemingly similar operations have many variations depending on the type of material for rendering and the type of equipment used. Many renderers have sacrificed good plant practices, preferring to devote more attention to the procuring of raw material. Inefficient inplant practices not only lower the quality of fat or tankage produced but raise operating costs. Improper "charging" or loading of cookers, overcooking, or leaking steam can raise plant operating costs by requiring more fuel, electricity, and maintenancd.

The slaughterer generally has an advantage over the renderer by having fresh clean raw material with a low free fatty acid content. This makes it possible for slaughterers to produce 85 to 100 percent light fats. The commercial renderer, through the proper separation and preparation of raw material, should be able to produce 40 to 80 percent light fats (11, p. 17).

The rendering of inedible tallow and grease can be divided into 5 operations as follows:

1. Separation of raw material
2. Preparation of raw material.
3. Cooking.
4. Separation of fat from tankage.
5. Settling and storage of fat.

The grinding and bagging of meat scrap or tankage is a sixth operation in some plants.

Separation of Raw Material

If a light colored, high quality fat is desired, it is necessary to separate dirty or decayed material from fresh clean material of a low free fatty acid content. For the slaughterer, this means the separation of skimmings from catch basins or from condemned or fallen animals, and other dirty or decayed material. In each State, 44 percent of the renderers separated raw material at the plant.

Most renderers did not separate raw material for the production of a high quality fat but for 3 other reasons. First, some renderers desired to cook some material such as fat and bones quickly, $1\frac{1}{2}$ to 3 hours, while offal and bones took 3 to 8 hours. Second, by separating raw materials and then "blending" together in fixed proportions the fat, bones, and offal, a predetermined cooking time (about $3\frac{1}{2}$ hours) was followed. Third the tankage from fat, bones and offal when "blended" together was more uniform and was easier to press.

Only 36 percent of the slaughterers reporting separated raw material for cooking. Since slaughterers have fresh clean raw material which is more uniform than a renderer's, it was not as necessary for them to separate raw material. It is important that slaughterers and renderers do not render dark fats along with clean light fats where they have sufficient volume of each. Household or restaurant grease, storage tank settlings, and sludge from fat washings should be separated. Generally these low quality greases can be held until a sufficient amount is accumulated to run an entire cook.

Mixing 10 to 15 percent catch basin skimmings, restaurant grease, or other dark fats to clean light fats lowers the quality one or two grades. The lowering of extra tallow by only one grade--to No. 1 tallow--would result in a loss of 0.95 cents per pound using the 1947 to 1957 average value (3, p. 162). A renderer who produced one million pounds of No. 1 tallow a year can experience a gross loss of over $8,000 a year by adding this small amount of dark fats to light fats. 8/ However, the additional man-hours necessary to keep the fats separated and the cost of separate storage facilities must be considered to determine if this practice is economically feasible. It appears that the preparation of raw material and the storage of fat after cooking have a greater effect on quality than does the separation of raw materials.

Preparation of Raw Material

The preparation of raw material is one of the most important steps in the rendering of inedible animal fats. Slaughterhouse offal and fallen animals contain fat splitting enzymes which, if not removed before the material enters the cooker, cause high free fatty acid fat. The manure and stomach contents contain a considerable amount of coloring matter and if not removed result in a dark colored fat. The complete removal of foreign material such as dirt, paper, and manure from all material is essential for the production of a high quality fat.

The best way to remove foreign material and manure from animal offal is through the correct use of a hasher-washer. The hasher cuts all the material into small pieces by passing it through a series of rotating saw blades or knives, the purpose being to expose the manure to the action of water in the washer. A hammermill or "hog" is unsatisfactory if proper washing is to be done. It imbeds the manure in the tissues, making complete removal impossible. The washing of hashed material is done in a cylinder made of perforated sheet metal rotating at a low speed where the hashed material is subject to a spray of water. Many renderers and slaughterers who had washers or hasher-washer combinations did not operate them properly. The most common faults found were overloading the washer, insufficient water and water pressure.

8/ If the 15 percent dark fats were rendered separately, the renderer would produce 850,000 pounds of extra tallow a year valued at 0.95 cent per pound more than No. 1 tallow or a total added value of $8,075.

The following practices are recommended for correct operation of a hasher-washer or washer (11, p. 19):

1. Keep hasher blades sharp.
2. Use a washer 18 feet in length.
3. Keep the washer at a correct slope.
4. Feed material in at a uniform rate.
5. Set the washer at 20 to 24 revolutions per minute.
6. Keep the temperature of wash water 100-110° F.
7. Keep the pressure of water at 60 pounds per square inch.
8. Use inside and outside spray lines.

The preparation of raw material by most of the slaughterers and renderers could be improved. Only 64 percent of all slaughterers and 7 percent of the renderers in this study had washers. Many of these washers were not properly operated and the offal was not thoroughly cleaned. 9/ Clean material does not need washing but almost all renderers had a certain amount of offal and fallen animals which needed washing. This small amount of unwashed material cooked with clean fat and bones lowered the quality of all the fat rendered. Most renderers reporting the "slitting and dumping" of the paunches did not complete the operation by thoroughly washing them.

A hog, hasher, hammermill or prebreaker is used to grind the bones, heads, feet, heavy tissues, and whole carcasses into pieces no larger than 2 inches. Fifty-eight percent of the renderers and 76 percent of the slaughterers reported using a grinder. The grinding of material is necessary where it is transported to the cookers by mechanical means such as blowtanks, packer pumps, or conveyors. Grinding also facilitates easier loading, faster cooking, and easier unloading of the cookers. Grinding also results in a more uniform material for pressing, and easier agitation of material in the cooker. All the renderers in this study who used screw presses ground their raw material. There were three kinds of grinders or hammermills used by the renderers and slaughterers: a hog, hasher, or prebreaker (see Glossary).

The "prebreaker" is new and its use not widespread. Several renderers who had installed one reported excellent performance and less power requirements than other grinders of equal capacity.

Cooking

There are several methods of breaking down the cells of animal tissues so that fat is released. The most common methods are wet and dry rendering but several other processes such as Chayen, Pavia, Kingans, and Sharples have been

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9/ By improving the washing job alone, upgrading from fancy to special tallow was made possible (11, p. 20). In an experiment on washing offal, tallow from poorly washed material had a 19 F.A.C. raw color and a refined and bleached color of 6.6 red on the Lovibond scale. Thoroughly washed material of the same type yielded light tallow with an F.A.C. color of 7 and a refined and bleached color of 0.5 red.

used successfully. "Solvent extraction" is not a method of cooking fat but a method of removing the fat from the tankage after it is cooked in a dry rendering cooker. All establishments contacted for this study used either wet or dry rendering. In wet rendering the material is subjected to direct steam or is boiled in water in a vat. The fat breaks free and floats to the surface where it is skimmed off. The disadvantage of wet rendering is that contact of water with fat increases the free fatty acids and the drying of tankage is relatively expensive. Six of the slaughterers and renderers of the 105 plants cooperating in this study rendered their inedible animal fats by the wet rendering method. The tallow and grease rendered in these 6 plants represented 2 percent of the total production of fat for all renderers visited.

A dry rendering cooker is generally a horizontal steam jacketed cylinder equipped with an agitator holding 2 to 10 tons of raw material. Material is loaded into the horizontal cooker through a dome cover and unloaded through a cooker door at one end. Most of the cookers in the plants visited were 4 x 7, 5 x 10, and 5 x 12 feet in size. Renderers tended to use larger cookers than slaughterers. The approximate cooker specifications and costs are shown in table 9.

Overcharging (loading the cooker too full) may result in poorly cooked material by not allowing sufficient room for expansion and the release of steam as the moisture is evaporated. Undercharging reduces the amount of material which can be processed and results in inefficiency. A mixture of material such as bones, shop fats, and offal can usually be loaded to the maximum level. Renderers reported that the addition of from 40 to 50 percent bone to each charge helped in scouring the inner jacket surface, took less power to run the agitator, and gave the tankage open texture which greatly facilitates extraction.

The final moisture content of the tankage is important in that it indicates whether the material is overcooked or undercooked. The optimum moisture content is usually assumed to be 8 to 10 percent. Renderers reported cooking material until 4 to 14 percent moisture remained. Since 1950 an additional number of renderers have been installing an endpoint control which measures the moisture content of the tankage. Less than one-third of the plants visited, however, used a mechanical method for determining when the cooking was completed. The most common method of determining the endpoint of cooking is to sample the tankage by "feel." When tankage rolled between the fingers feels sandy and dry, the excess moisture has been evaporated and the cook is complete.

Undercooking leaves too much moisture in the tankage and makes pressing more difficult. Overcooking results in the burning (oxidation) of fat and tankage, and lowers the quality of both. Overcooking also reduces the yield of fat during pressing and causes excessive fines. These excessive fines not only result in a higher M.I.U. (see Glossary) content of fat but cause excessive wear to screw presses.

Table 9.--Approximate cooker specifications

Nominal cooker size, diameter x length, feet	Approximate internal volume	Load rating (water) 1/	Approximate agitator motor power 2/	Approximate boiler power 3/	Approximate price 4/
	Cubic feet	1,000 pounds	Horsepower	Boiler horsepower	Dollars
2 x 6	10	--	3	--	3,600
3 x 4 5/	20	--	5	10 - 15	5/1,600
4 x 4	40	--	10	30	4,200
4 x 7	70 - 85	4 - 5	10 - 25	25 - 35	6,000 - 6,200
4 x 7 5/	65	--	10	25 - 30	5/3,100
4 x 9 5/	80	--	15	35	5/3,800
4 x 10	100 - 130	6 - 7	20 - 25	35 - 50	6,700 - 7,500
5 x 10	160	8	20 - 25	45 - 50	7,500
5 x 12	200 - 220	10	30	50 - 75	7,700 - 8,500
5 x 16	250	--	30	--	12,000
6 x 9	230	--	40	80	9,000
6 x 12	350	--	40	--	--

1/ Load ratings are arbitrary ratings. Manufacturers recommend charging the cooker to 60-80 percent of the total volume with offal or blood.
2/ Agitator motor power should be increased for cookers processing feathers. Manufacturers recommend 20-50 percent more power.
3/ Boiler horsepower requirements are reduced where more than one cooker is operated. The load on the boiler is greatest at the beginning of a cook. With two or more cookers, cooker start-ups can be staggered to reduce peak-load steam demand.
4/ Motors and boiler are not included. Other auxiliaries such as valves and pressure gages are included.
5/ These prices apply to cookers not built to stand any internal pressure. The other cookers listed are built for a 45 p.s.i.g. internal pressure in addition to a 90 p.s.i.g. pressure. (See Glossary for abbreviation.)
Data from Mktg. Res. Rpt. No. 181, table D-2, page 52, U.S.Dept.Agr., June 1957.

Agitator Speeds

Agitator (paddle) speeds used in the rendering plants reported varied from 18 r.p.m. (revolutions per minute) to 38 r.p.m. In some cases, increasing the agitator speed from 22 to 38 r.p.m. has reportedly reduced the cooking time by as much as 30 percent (7, p. 56). Older cookers in plants generally had agitator speeds ranging from 20 to 24 r.p.m. while those for new cookers were 34 to 38 r.p.m. For material such as offal, a faster agitator speed is generally recommended.

Jacket Pressure

Steam pressures of cooker jackets ranged from 40 to 100 p.s.i. (pounds per square inch). Most jacket pressures were in the 60 to 80 p.s.i. range. A high jacket pressure promotes faster heat transfer and shortens cooking time. It is believed that burning of fat generally occurs near the end of the cook when the fat is thrown against the top of the cooker. To keep fat from burning, some experimental research has been done on the construction of a cooker in which the steam is used only in the bottom half of the cooker after the cooking is partially completed. The reports of this research indicate that a shorter cooking time and a higher grade tallow is possible.

Seventy-one percent of the renderers and slaughterers reporting had condensers connected to the exhaust pipe of the cookers to reduce the discharge of odors into the air. These condensers are generally barometric condensers which, in addition to reducing odor, tend to create a partial vacuum in the cooker.

Cooking Time

The time required for cooking is dependent upon the moisture of raw material, agitator speed, and jacket pressure. Renderers and slaughterers reported that material of low moisture content, such as shop fats, was cooked within $1\frac{1}{2}$ to 3 hours, while offal took 3 to 8 hours. In order to maintain a more uniform cooking time, most renderers blended fat, bones, and offal together, charging the cooker with material containing about 50 percent of moisture.

Additional research is needed to determine the specific operating procedure that will give an optimum production rate and optimum quality of fat. In summary, it appears that a low-cooking temperature, low agitation speed, and short cooking time tend to give a better quality product. These requirements are somewhat contradictory, however, and a suitable compromise of all operating procedures should be selected for each rendering plant.

Separation of Free Fat

When cooking is completed, the entire content of the cooker is dumped into a percolating pan where the free fat can drain from the tankage to a settling tank. The percolating pan is generally a rectangular tank with a screen of 1/8-inch holes placed 6 inches above the bottom. Tankage should remain in the percolating pan long enough to drain the free fat but not long enough to become cold. The temperature of the tankage should be 180° F. or higher for best pressing. Many renderers heat the bottom of the percolating pan. The heat must be used with caution to avoid burning the fat or causing settlings to sour. The unloading of percolator pans in all but a few of the plants visited was done by shoveling the tankage into a conveyor or hydraulic press. For most renderers it would be possible to replace this manual unloading of percolator pans by mechanical means and eliminate costly labor. Automatic unloading percolator pans are relatively new and two general types are in use, those which drag the tankage on an endless chain conveyor out of the pan and those which lift and dump the entire pan.

Solvent Extraction

Four of the plants in this study used the solvent extraction process to remove animal fat from tankage. Almost all the fat can be removed from tankage by the solvent extraction process; thus, when the value of tallow and grease is high, renderers have been prone to install this method. The fat is removed from the cooker by a volatile liquid, generally naphtha. The mixture of fat and naphtha, called "miscella," is then distilled to remove the fat. The advantage of this method is the almost complete removal of fat from tankage and low labor requirement per ton of fat rendered. Some of the objections to this form of fat extraction are the initial investment, fire hazard, competent supervision required, and the large volume of raw material necessary.

Presses

There are two types of presses used for extracting fat from tankage: Curb presses (sometimes called cage or hydraulic presses) and screw presses (also called expellers). Seventy-three percent of the slaughterers and 48 percent of the renderers used curb presses. These presses are batch operations and require 30 to 60 minutes to load, press, and discharge the tankage. Thus, assuming a 45-minute average batch pressing time, curb presses of 150 to 600 ton capacity can process 370 to 670 pounds of tankage per hour (7, p. 59).

Screw presses, used by 35 percent of the dry rendering operations visited, have a capacity of 300 to 2,000 pounds of tankage per hour. Screw presses are designed for continuous operation and lend themselves well to a mechanized plant. Whereas the operation of a curb press requires the full-time attention of one man, the screw press can be operated with 25 percent of a man's time (7, p. 59). When using a screw press, raw material must be ground prior to cooking so that it can be fed into the worm shaft. The screw press, when operated properly should give press chips with a residual fat content from 7 to 9 percent. Some renderers have reported that a screw press will only press to 12 percent fat while a curb press will only press to 13 percent fat (7, p. 59). Many renderers felt that only skilled personnel could properly operate screw presses and that the maintenance cost per ton for screw presses was too high. Over-cooked tankage can cause excessive wear to barrels of screw presses due to the excessive amount of fines present in the tankage. For one renderer, who unloaded his cooker at 10 percent moisture, it was necessary to have the screw press rebuilt only every 18 months. Although the cost of a screw press is greater than a curb press, the capacity in pounds per hour is much greater, thus lowering the unit capacity cost (tables 10 and 11).

Table 10.--Curb press capacities and costs

Nominal size	Tankage pressed 1/	Approximate total cost	Unit capacity cost
Tons	lb./hr.	Dol.	Dol./lb./hr.
150	370	5,000	13.50
300	530	8,700	16.40
600	670	11,700	17.50

1/ Assuming 45 minutes average pressing cycle time.

Reproduced from U. S. Dept. Agr., Mktg. Res. Rpt. No. 181, table No. D-9, p. 60.

Table 11.--Screw press capacities and costs 1/

Capacity	Approximate total cost	Unit capacity cost
Lb./hr.	Dol.	Dol./lb./hr.
500	5,200	10.00
1,000	14,000	14.00
2,000	38,000	19.00

1/ Based on estimate made from curb presses that cost increases approximately by the 1.43 power of the increase in capacity.

Reproduced from U. S. Dept. Agr., Mktg. Res. Rpt. No. 181, table No. D-10, p. 60.

Grinding and Bagging of Tankage

The grinding of tankage must be done at some stage before it is compounded into animal feed. Many small renderers prefer to sell their tankage unground or in a pressed cake form since the small volume does not warrant the investment of grinding and bagging equipment. This is particularly true of tankage pressed in a curb press. Sixty percent of the renderers and 25 percent of the slaughterers doing dry rendering had grinding and bagging equipment which require additional man-hours when used. However, many of these renderers only ground a small percentage of their tankage. Fifty-two percent of all the tankage produced by renderers and slaughterers was sold in bulk form. The grinding of tankage at the rendering plant is dependent upon the demand for bagged or bulk tankage. For this reason most renderers sold tankage both bagged and in bulk. The market value of unground tankage is generally $12.00 to $15.00 per ton less than that for ground and bagged, and it has the same protein value per unit. Many renderers reported being able to grind and bag tankage for $12.00 per ton. Eighty percent of all renderers and slaughterers reporting sold their tankage or meat scrap direct to animal feed manufacturers.

Hammermills are used for the finishing grind, commonly 7 or 12 mesh. In some instances separate crushers are used to break the pressed cake and prepare it for the hammermill. However, many hammermills are now manufactured with a built-in cake-crushing mechanism. The capacity, horsepower requirements, and costs of grinding equipment are shown in table 12.

Table 12.--Grinder data and costs

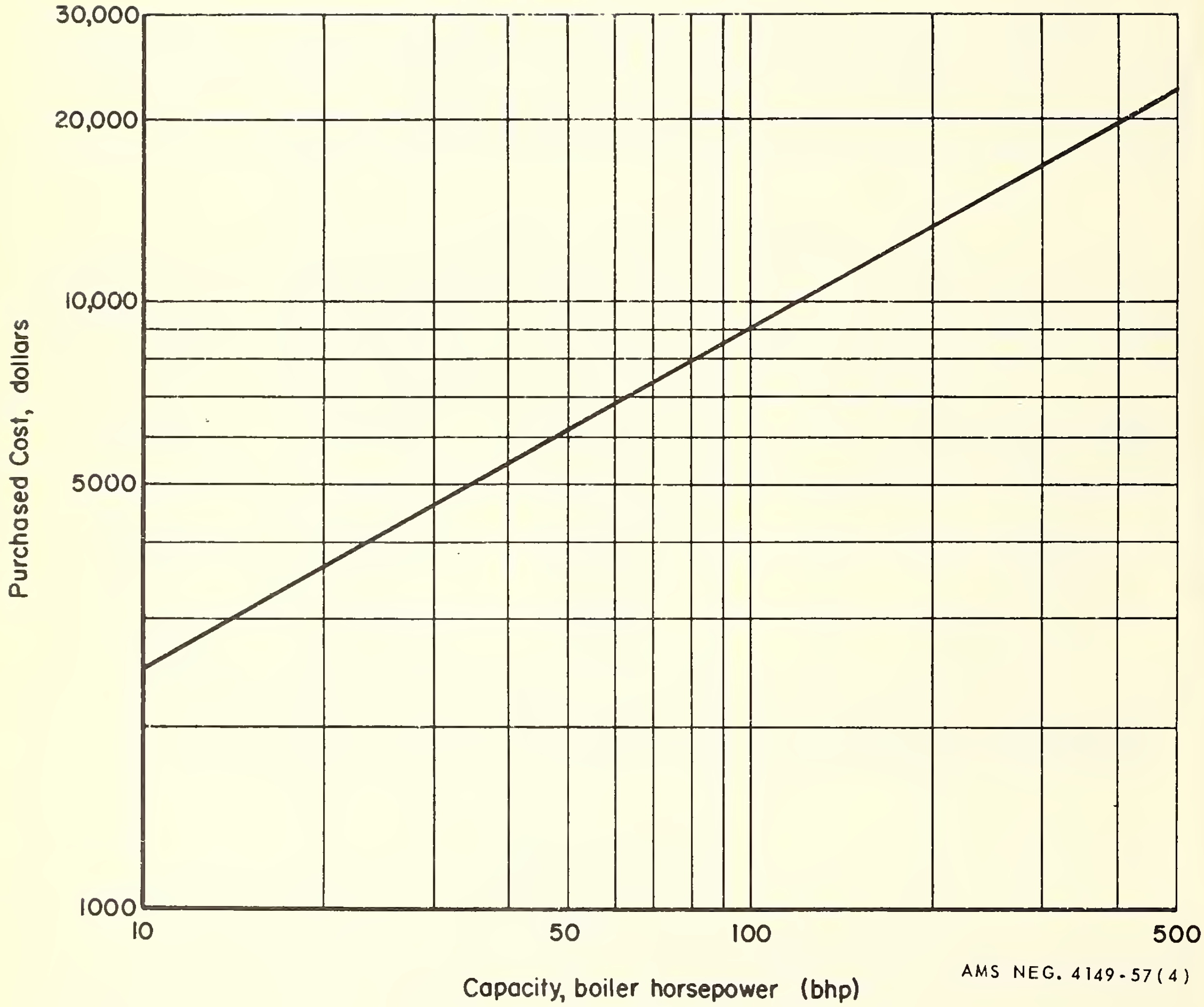
Maximum capacity	Horsepower	Approximate price	Approximate motor and starter price	Approximate total price
Tons per hour:		Dollars	Dollars	Dollars
0.5	15	870	360	1,230
1.0	25	1,300	680	1,980
1.25	30	1,500	770	2,270
1.5	40	1,680	870	2,550
2.0	50	2,000	1,120	3,120
2.5	60	2,300	1,570	3,870

Reproduced from Marketing Research Report No. 181, table No. D-11, p. 61. U. S. Dept. Agr. June 1957.

Steam Generation

Gas or oil to generate the steam necessary for cooking was used in 50 percent of the plants reporting the type of fuel used. Most of the rendering operations using gas or oil were small. The cost of using gas or oil was generally believed to be one-third higher than for coal, but in a small plant the use of gas or oil could save the labor of one man otherwise used to fire the boilers. For large renderers, the amount of steam necessary for plant operation justified the use of coal since it was less costly in volume than other fuel.

Boiler cost has been estimated at approximately $5,000 for a 35 BHP (boiler horsepower) boiler and $15,000 for a 250 BHP boiler (fig. 4). These figures are derived from actual boiler purchases made for rendering plants in recent years (7, p. 62). A recommended steam capacity of 25-35 BHP is needed for a 4 x 7 cooker, and 50-75 BHP for a 5 x 12 cooker. A cooker will operate with an insufficient boiler capacity, but the cooking time is lengthened.



(Reproduced from Marketing Research Report 181, p. 63, U. S. Dept. Agr.)

Figure 4.--Boiler costs

Fuel, Electricity, and Water Costs 10/

Fuel for producing steam, power for the various electric motors, and water requirements can be approximately related to the quantity of water evaporated during the processing. The energy required to evaporate 1 pound of water, heat the material, and provide for the thermal efficiency of the boiler and cooker requires 1,765 B.t.u. (British thermal units). Using an assumed fuel oil price of $0.14 per gallon or a natural gas rate of $1.00 per MSCF (thousand standard cubic feet), the fuel cost will be $0.001765 per pound of water evaporated or $3.53 per ton of water evaporated.

Power consumption has been estimated from actual rendering plant costs to be approximately 10 kw.-hr. per million B.t.u. of fuel consumed, which corresponds to 10 kw.-hr. per MSCF of natural gas. Assuming a power rate of $0.03 per kw.-hr., and 0.01765 kw.-hr. of power required for every pound of water evaporated, power cost will be equivalent to $0.00053 per pound or $1.06 per ton of water evaporated.

The major use of water is for the condensation and cooling of cooker vapors. Well water is a common source for cooling water. It is estimated that approximately 75 gallons per minute (gpm) are required for a 4 x 7 cooker and 150 gpm are required for a 5 x 12 cooker. Cooling water consumption can be related to water evaporation; approximately 10 gallons of cooling water are required per pound of water evaporated. For the costs estimates, it is assumed that well water can be furnished at a cost of approximately $0.02 per thousand gallons. Thus, the cooling water cost is estimated to be $0.0002 per pound or $0.40 per ton of water evaporated.

SETTLING, STORAGE, AND QUALITY CONTROL OF FAT

Settling

The settling of free fat from the percolator pan and the fat pressed from tankage is done in a rectangular tank holding 100 to 500 gallons of fat. The fat is settled to remove moisture and impurities. The entire content of the tank should be heated to a temperature of 190° to 200° F. and then left to settle for a minimum of 8 hours (11, p. 42). Any heating during settling should be avoided. Fat should not be reheated before being pumped to the settling tanks. It is extremely important to read the color of the fat at this time to determine grade of fat. Light and dark fats should be pumped into separate tanks if the maximum value for each grade is to be realized.

10/ Adopted from Marketing Research Report No. 181, Processing Poultry Byproducts in Poultry Slaughtering Plants. U. S. Dept. Agr., Washington, D. C. June 1957.

In most rendering operations fats are not washed and filtered to remove additional moisture and impurities. These operations require extensive equipment and close supervision. A few large renderers had sufficient facilities but for the average renderer it is necessary to have a large volume of inedible fat for processing to justify the capital investment. The stabilizing of fat which is necessary if the fat is to be used in animal feed was done by 20 of the 105 renderers and slaughterers reporting.

Storage

Fat must be stored until a sufficient volume is available for sale. There are three methods by which fat is commonly sold: Loaded tank cars, tank trucks and drums. Drums act as storage tanks and are filled from the settling tank. Thirty-eight percent of the slaughterers and 24 percent of the renderers in Pennsylvania and Minnesota sold their fat in drums and had no storage tanks. Slaughterers and renderers selling fats in bulk required storage facilities of at least 60,000 pounds or 8,000 gallons. The cost of storage tanks is shown in table 13. When the fat in the storage tank is heated for pumping out, it should be done slowly and never over 160° F. to avoid burning. Continuous heating or a high temperature will cause the color of the fat to become darker.

Table 13.--Tank and storage cost for inedible tallow and grease

Description	Use	Approximate size gallons	Cost per gallon	Cost per pound
		Gallons	Dollars	Dollars
Small grease tanks	Receiving and holding	100 - 500	0.50	--
Large grease tanks	Storage	10,000	.15	--
Metal storage bins	Receiving and holding	10,000	.40	0.05 - 0.10
Floor storage bins	Storage	10,000	0.10 - 0.15	0.01 - 0.04

Data from Marketing Research Report No. 181, table D-13, page 65. U. S. Dept. Agr.

Many renderers and slaughterers do not have sufficient storage facilities. Forty-four percent of the renderers and 43 percent of the slaughterers in this study had facilities for storing less than 10 percent of their total annual production at any one time (table 14). The renderers reported having to sell their inedible fat every 3 to 4 weeks regardless of the market value for fat. Of greater significance is the fact that 12 percent of the renderers and 33 percent of the slaughterers storing fat in bulk had only one storage tank. With only one storage tank it is impossible to keep light and dark fats separated. Usually both renderers and slaughterers have a small amount of low-grade (dark) fat rendered from catch basin skimming, fallen or condemned animals or house grease and these low-grade fats should be stored separately. The blending of yellow grease to choice white grease can result in lowering the choice white grease several grades but only raising the dark fat one grade, so it is more profitable to store and sell the light and dark fat separately. Inedible fats will not deteriorate seriously in quality when properly stored, providing they are not exposed to heat or moisture.

Table 14.--Distribution of Pennsylvania and Minnesota rendering and slaughtering plants by number of storage tanks and the percent of annual production of fat which can be stored, 1956 1/

Type of plant	Distribution of plants							
	Number of storage tanks				Storage capacity as a percentage of annual production			
	1	2	3	4 or more	Less than 10	10-20	21-30	Over 30
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Rendering	12	34	36	18	44	22	18	16
Slaughtering ..	33	32	10	5	43	14	19	24

1/ Twelve slaughterers and 17 renderers stored their tallow and grease in drums and are not included.

Quality Control

The renderer also should be able to run 3 of the tests at his plant in order to determine into which storage tank his tallow should be pumped and to maintain quality control. The three tests include: Color, moisture, and free fatty acid. Very few of the rendering plants cooperating in this study did any testing. Most renderers believed that chemical analysis required extensive equipment and could be done only by trained chemists. Several plants had invested $50 to $500 in testing equipment which any competent employee could use in testing fat for color, moisture, and free fatty acid. Results of such tests are not accurate enough for purchasing specifications but they help in the control of quality during processing and storage.

LABOR REQUIREMENTS, WAGES, AND MECHANIZATION

Variation in Labor Requirements

Labor requirements ranged from 2.7 to 29.7 man-hours per ton of (fat and tankage) product produced. The average man-hours per ton of product produced was 12.2 for slaughterers and 11.1 for renderers. The 5 most efficient slaughterers averaged 3.7 man-hours per ton of product; 5 best rural renderers, 4.4 man-hours per ton; and 5 best metropolitan renderers, 3.9 man-hours per ton. Mechanization and other plant efficiencies resulted in these low man-hour requirements. Table 15 shows the high, low, and average man-hours used per ton of product for slaughterers and renderers. In general, as production increased, the man-hours necessary to produce one ton of product decreased, indicating reduced costs with a larger volume. However, some of the plants with the lowest man-hour requirements were small. These plants were generally compact in their operation and efficiently managed.

Table 15.--Average and range of man-hour requirements per ton of fat and tankage produced for Pennsylvania and Minnesota rendering plants, 1956

Production per year	Slaughterers			Renderers		
	Plants	Average	Range	Plants	Average	Range
	Number	Man-hours	Man-hours	Number	Man-hours	Man-hours
Tons:						
Less than 500 ..	19	13.6	4.3 - 29.7	12	13.3	2.9 - 18.6
500 - 999	1	12.0	---	13	9.0	6.2 - 14.8
1,000 - 1,499 ..	4	6.7	3.6 - 13.2	9	10.3	4.3 - 19.7
1,500 - 1,999 ..	3	10.9	2.7 - 16.5	8	12.3	3.1 - 26.4
2,000 - 3,999 ..	5	12.0	3.2 - 20.6	18	11.9	4.0 - 28.4
Over 4,000	---	---	---	6	8.8	4.6 - 19.9
Total or average	32	12.2	2.7 - 29.7	66	11.1	2.9 - 28.4

There is also a relationship between production of fat and tankage per cooker and production per man-hour (table 16). Usually those plants with the lowest man-hours per ton of product had a fuller utilization of each cooker. Those plants using one large cooker instead of three small ones or rendering several cooks per day in one cooker generally had lower man-hour requirements. Along with the lower man-hour requirements, an additional saving in capital investment was made possible by a fuller utilization of existing cookers. Generally, the more material a renderer can process through each cooker, the lower will be the man-hour requirements per ton.

Labor requirements per ton of product vary greatly among rendering plants. The five major reasons for these varying labor requirements are: Handling of fallen animals; type of pressing; grinding and bagging of tankage; firing of boilers; and plant mechanization.

Handling Fallen Animals

When renderers collect fallen animals, additional help is needed to skin the animals. In some plants the skinning and quartering of one large animal

Table 16.--Average and range of man-hour requirements for production of fat and tankage per cooker for Pennsylvania and Minnesota rendering plants, 1956

Production per cooker	Slaughterers			Renderers		
	Plants	Average	Range	Plants	Average	Range
	Number	Man-hours	Man-hours	Number	Man-hours	Man-hours
Tons:						
Less than 99 ..	5	9.8	4.3 - 19.7	3	9.6	2.9 - 16.9
100 - 199	6	17.6	8.5 - 29.7	5	13.6	8.6 - 18.6
200 - 399	8	13.0	5.3 - 31.8	11	11.3	5.6 - 26.4
400 - 799	8	11.4	2.7 - 20.6	21	9.6	3.1 - 19.7
800 - 1,599 ...	5	8.4	3.6 - 16.5	23	11.9	4.3 - 28.5
Over 1,600	---	---	---	4	6.2	4.6 - 8.7
Total or average	32	12.2	2.7 - 31.8	67	10.8	2.9 - 28.5

required $\frac{1}{2}$ hour, while in other plants this work could be accomplished within 10 to 15 minutes. Under ordinary conditions, one man can skin and quarter about 4 fallen cattle per hour. The use of electric shears to remove the hides helps to avoid cuts which would reduce the value of the hides. Prebreakers, hogs, or crushers which can accommodate whole animals reduce the labor necessary to quarter the animal. Electric winches to pull the hide and air injected into the animal to loosen the hide facilitate the handling of fallen animals. The use of a "rail" such as slaughterers use to suspend the carcass of an animal by the hock makes it easy to skin the animal and move it through the plant.

Type of Pressing

The type of presses used has a great effect on the man-hour requirements. It has been estimated that screw presses require 25 percent of a man's time compared with 100 percent for curb presses (7, p. 59). Since the curb press is loaded and held under pressure for 45 minutes, a cycle of about one hour occurs between each press. Some renderers who had a large amount of tankage to be pressed but not enough pressing facilities had to load and unload the press every 30 to 45 minutes. This results in poor pressing which leaves from 12 to 15 percent fat in the tankage. A few renderers used conveyors to load the curb presses but the unloading and storing of pressed cake is a manual operation. If the man-hours for those renderers using curb presses are to be lowered, the rendering operation must be organized so that the men have other duties while the tankage is in the press.

Screw presses are well adapted to mechanized rendering plants since they permit a continuous movement of material through the plant. Although the initial cost is somewhat higher for screw presses, the volume of material that can be pressed per hour is greater (tables 10 and 11). Comparison of the most efficient plants using screw presses and curb presses (tables 17 and 18) indicate that those using screw presses had lower man-hours of labor per ton of product produced.

Grinding and Bagging of Tankage

Additional labor is necessary if renderers grind and bag their tankage. Most renderers felt that a slight profit was gained in grinding and bagging tankage. Most of the large renderers who ground their tankage reported that one man could grind and bag one ton of tankage per hour. Usually two men work together in this operation; one man grinds while the other man takes the bagged tankage to the storage area. Also, additional labor is required if pressed cake is fed through a cake crusher before actual grinding. The man-hour requirements vary greatly depending upon the amount ground, type of pressing done, type of grinder used, and whether the mixing of other protein supplement with the tankage is done. Two renderers who conveyed their tankage directly from a screw press into the grinder were successful in lowering man-hour requirements for grinding. To permit this practice, the tankage must move slowly from the screw press to the grinder so it will cool before grinding. The use of a fan in one plant helped to cool the tankage when it was ground immediately after pressing.

Firing of Boilers

The labor used to fire the boilers was included in production of fat and tankage per man-hour (table 14) and no attempt was made to separate the man-hours for this operation. Several small renderers producing less than one million pounds of fat were of the opinion that one less man was needed to fire the boilers when oil or gas was used. If this is true, the additional cost of the oil or gas over coal was compensated for by the saving in wages of one man.

Mechanization

In many of the plants visited, labor requirements could have been reduced by the use of conveyors, charging carts, blow tanks, and automatic dumping percolator pans. Large rendering operations generally utilized some or all of these labor-saving innovations. This, in part, accounts for their lower man-hour requirements. From observations of rendering operations, more conveyors could have been used to facilitate the movement of material within the plant. Many times barrels of raw material were rolled 50 to 75 feed across a floor and then dumped into a cooker. In some plants it was necessary to shovel the raw material from the hog or crusher into wheelbarrows for moving to the cooker. Other plants with screw presses did not use a portable conveyor to move pressed tankage to the storage area. The number and use of conveyors, blow tanks, charging carts and automatic dumping perolator pans was noted at each of the

Table 17.--Labor used in selected types and sizes of rendering plants and the cost of labor per ton of fat and tankage produced, 1956

Plant and major equipment	All plants			Most efficient plant		Labor costs per ton of product 1/	
	Reporting	Average annual production of tankage and fat	Average labor per ton of product	Total annual production of tankage and fat	Labor per ton of product	All plants	Most efficient plant
	Number	Tons	Man-hours	Tons	Man-hours	Dollars	Dollars
Plant A: 2 cookers, 2 curb presses, Grind and bag 100 percent 2/	3	1,263	10	1,260	8	13.50	10.80
Plant B: 2 cookers, 1 to 3 curb presses, No grinder 3/	3	2,512	12	3,250	7	16.20	9.45
Plant C: 3 cookers, 1 screw press, No grinder 3/	3	1,567	7	1,820	3	9.45	4.05
Plant D: 5 cookers, 1 to 2 screw presses, Grind and bag 65 percent 4/	8	1,578	13	2,125	4	17.55	5.40

1/ Based on average hourly wage of $1.35 for plant labor.
2/ Cookers range in size from 5 x 10 to 5 x 12 feet.
3/ Cookers range in size from 4 x 9 to 5 x 10 feet.
4/ Cookers range in size from 4 x 7 to 5 x 10 feet.

Table 18.--Labor used in selected types and sizes of slaughtering plants and the cost of labor per ton of fat and tankage produced, 1956

Plant and major equipment	All plants			Most efficient plants		Labor costs per ton of product	
	Reporting	Average annual production of tankage and fat	Average labor per ton of product	Total annual production of tankage and fat	Labor per ton of product	All plants 1/	Most efficient plant 1/
	Number	Tons	Man-hours	Tons	Man-hours	Dollars	Dollars
Plant A: 1 cooker 4 x 7, 1 curb press, No grinder	4	285	11	335	6	20.02	10.92
Plant B: 2 cookers 5 x 9, 1 curb press, No grinder	4	507	17	863	12	30.94	21.84
Plant C: 2 cookers, 1 screw press, No grinder 2/	2	2,370	9	3,900	3	16.38	5.46
Plant D: 2 cookers, 1 curb press, No grinder 3/	3	1,295	17	2,350	8	30.94	14.56

1/ Based on average hourly wage of $1.82 for plant labor.
2/ Cookers range in size from 4 x 7 to 5 x 9 feet.
3/ Cookers range in size from 5 x 10 to 5 x 12 feet.

plants visited. Only 21 renderers and 4 slaughterers had what could be classified as adequate facilities for the movement of raw materials and finished products through the plant. Renderers generally tended to have more mechanized operations than slaughterers. Many renderers and slaughterers were unable to install conveyors and other mechanization owing to a lack of space.

Continuous Plant Operation

Of the 66 renderers reporting hours of plant operation, 50 worked one shift, 11 two shifts, and 5 three shifts. Seven of the 27 slaughterers reporting worked more than one shift. Most renderers who found it necessary to operate over 8 but less than 11 hours a day employed a split shift. Under this arrangement part of the labor force started at 7 o'clock in the morning and the other part at 12 o'clock. The use of split shifts made it possible for the raw material arriving at the plant late in the afternoon to be cooked and pressed the same day it was collected. For some renderers and slaughterers, the plant employees did not begin work until late in the morning after the raw material had been delivered.

It appears that the production per man-hour was not lower in those plants operating more than one shift. Of the 17 slaughterers and renderers who had 5 or less man-hours per ton of product, only 2 operated more than one shift per day. However, the operation of a rendering plant on a round-the-clock basis even if limited to a 5-day week, would greatly increase the product tonnage over which the fixed charges (e.g., maintenance, depreciation, insurance, local taxes) could be spread and thus lower operating costs on a weekly basis.

Of the 66 renderers reporting, 3 operated less than a 5-day week, 10 operated 5 days a week, 14 operated $5\frac{1}{2}$ days a week, and 39 operated a 6-day week. Almost all renderers in Minnesota worked on a 6-day week since it was necessary to collect and render fallen animals as soon as possible. Of the 27 slaughterers reporting in Pennsylvania and Minnesota, 25 worked a 5-day week and 2 worked a 6-day week.

Wages of Drivers

There was a wide range in the hourly wage rates paid to drivers. These wage differentials are associated with location of the plant, size of plant, type of operation, local labor supply and wages paid by other local industries. This report does not attempt to relate wages to productivity per man-hour but to give some indication of the wages paid by renderers.

Three conclusions may be drawn from the data concerning wages paid to drivers. Pennsylvania renderers pay higher wages than Minnesota renderers; larger rendering plants pay higher wages, and metropolitan renderers pay higher wages than rural renderers. All renderers paid an average wage of $1.51 an hour to their drivers, with wages ranging from $1.00 to $2.80 per hour. Pennsylvania renderers paid an average wage of $1.63 and Minnesota renderers $1.29 per hour (table 19).

Table 19.--Average hourly wage paid to truck drivers by renderers in Pennsylvania and Minnesota, by size of plant, 1956

Volume of fat per year	Renderers				
	Pennsylvania		Minnesota		Average hourly wage 1/
	Reporting	Average hourly wage	Reporting	Average hourly wage	
	Number	Dollars	Number	Dollars	Dollars
Million pounds:					
Under 1.0	14	1.27	7	1.11	1.22
1.0 - 1.9	12	1.60	9	1.25	1.45
2.0 - 3.9	8	1.82	6	1.56	1.71
Over 4	6	2.28	--	--	2.28
Average or total 1/ ...	40	1.63	22	1.29	1.51

1/ Averages are weighted by the number of plants reporting.

In both States, as the size of the plant increased (measured by production of fat) wages paid to drivers increased (table 19). Many of these large rendering plants were located in metropolitan areas such as St. Paul, Pittsburgh and Philadelphia and it was necessary to pay wages comparable with those for other industries. These large metropolitan renderers paid an average of $2.20 per hour.

Wages paid to drivers by rural or small rendering plants in both States averaged $1.15 per hour. Since fallen animals were collected in the evenings or on weekends, drivers in rural areas had a considerable amount of overtime, raising their weekly earnings above $55.

Rendering plants located in metropolitan areas paid higher wage rates than rural plants. The largest rendering plants by volume were located in metropolitan areas and usually their drivers and plant employees received wages comparable with other local industries.

Some renderers reported curtailing their collection operations when drivers' wages were increased. This was done by discontinuing fallen animal collections, covering a smaller area in the collection of raw material, and discontinuing overtime work for the drivers.

Wages of Plant Employees

Four conclusions can be drawn from the data concerning wages of plant employees:

1. Plant employees are paid less than drivers.
2. Pennsylvania renderers pay higher wages than Minnesota renderers.
3. Larger rendering plants as measured by production of fat pay higher wages than smaller ones.
4. Slaughterers pay higher wages than renderers.

The wages paid by renderers to plant employees averaged $1.35 per hour and the wages paid to drivers averaged $1.51 per hour. Twenty-nine rendering plants paid the same wage to drivers and plant employees. There are two explanations for drivers receiving higher wages: the responsibility, lack of supervision, and contact with the public made it necessary to employ better qualified personnel as drivers; and drivers are paid more than most plant laborers.

Pennsylvania renderers paid an average of $1.40 to plant employees and Minnesota renderers paid $1.25 per hour (table 20). Many of the Pennsylvania renderers were located in industrial areas and it was necessary to pay plant employees wages comparable to surrounding industry. In Minnesota, renderers in rural areas could generally hire unemployed farm hands at $1.00 to $1.25 per hour.

Large rendering plants (when measured by production of fat) usually paid higher wages than smaller plants (table 20). Two factors contribute to larger rendering plants paying higher wages. These plants are located in urban areas and must pay the prevailing wage and more skilled personnel must be used in large plants to operate specialized modern equipment.

Pennsylvania slaughterers paid an average hourly wage of $1.79 and Minnesota slaughterers paid $2.00 per hour (table 20). Many of the slaughterers in Pennsulvania were small and did not employ union personnel which may have partly accounted for the lower average wage paid by Pennsylvania slaughterers. However, many Pennsylvania slaughterers paid higher wages than Minnesota renderers. Slaughterers can afford to pay higher wages to plant employees because collection costs are avoided.

All renderers in both States paid an average of $1.35 per hour and all slaughterers paid an average hourly wage of $1.82. The smaller wage paid by renderers was partly compensated for by the fact that their employees earned extra pay for overtime. Only 38 percent of the slaughterers operated their rendering operation more than 40 hours a week, whereas 84 percent of the renderers operated more than a 40-hour week. Thus the overtime paid by renderers helped to raise their employees' wages to a higher level.

Efficient Type and Size of Plants

Because rendering plants differ in size, the various operations could not be compared in the manner desired. Tables 16 and 17 indicate, however, the wide variations in the labor requirements, and costs of labor among rendering operations.

Table 20.--Average hourly wage paid to plant employees by renderers and slaughterers in Pennsylvania and Minnesota, by size of plant, 1956

Volume of fat per year	Renderers			
	Pennsylvania		Minnesota	
	Reporting	Average hourly wage	Reporting	Average hourly wage
	Number	Dollars	Number	Dollars
Million pounds:				
Under 1.0	16	1.25	8	1.12
1.0 - 1.9	12	1.48	9	1.29
2.0 - 3.9	8	1.52	4	1.41
Over 4	6	1.50	--	--
Average or total 1/ ...	42	1.40	21	1.25
	Slaughterers 2/			
Under 1.0	--	--	--	--
1.0 - 1.9	--	--	--	--
2.0 - 3.9	--	--	--	--
Over 4	--	--	--	--
Average or total 1/ ...	27	1.79	4	2.00

1/ Averages are weighted by the number of plants reporting.
2/ Wages paid by slaughterers are not given by size of plant to avoid disclosures.

Most of the slaughterers and renderers were small in terms of their production of fat and tankage. Many of the plants visited produced less than 500 tons of fat and tankage per year. Many of these small plants had low man-hours per ton of product without the use of mechanization. This resulted from a small, compact, and well managed operation. A typical example of a small efficient 2-cooker, 1 press slaughtering operation can be characterized as follows:

1. Raw material from the killing floor dumped directly into cooker.
2. Tankage dumped from cooker into percolating pan.
3. Tankage shoveled from percolator pan into a curb press beside the percolating pans.
4. Pressed cake unloaded from the press and stored nearby.

A small efficient operation such as the one described can produce 360,000 pounds of fat and 375 tons of tankage per year (555 tons of product) for each plant employee. The chief advantages of this type of operation are that it permits the use of a charging cart to dump raw material directly into the cooker and the pressing of the tankage at the percolator pans avoids moving it in the plant.

While some small plants may require very few man-hours, these savings in labor are often overcome by higher fixed costs per ton of output. The advantage of size in large inedible rendering plants is that the labor requirements and fixed costs per ton of product are usually lower since the costs are spread over a greater tonnage.

For larger rendering plants producing at least 1.5 million pounds (750 tons) of fat or over 1,500 tons of fat and tankage a year, the continuous movement of material and plant automation is necessary if the economies of scale are to be gained. The following operation is capable of producing annually 500 to 600 tons of product per plant employee, or a ton of product per 3 to 4 man-hours where screw presses are used:

1. The raw material is dumped from trucks into a pit where it is conveyed to the hasher, hasher-washer, hog, or prebreaker.
2. Raw material travels from the hasher, hasher-washer, hog, or prebreaker by a conveyor or blow tank to the cookers.
3. Tankage is unloaded from the cooker into the percolating pans.
4. Percolating pans are dumped or unloaded automatically into a conveyor which carries the tankage to the screw press.
5. The pressed tankage is carried by conveyor to the grinder and is bagged.

Several excellent operations of the above type were observed during the survey. These plants produced 1.5 to 3 million pounds of fat a year with 2 cookers, 1 screw press, and 2 plant employees. Through using 4 conveyors each, these plants achieve a continuous movement of material. Increased labor requirements were observed in some large plants which produced from 900 to 1,000 tons of fat and tankage a year. Such labor requirements usually resulted from a failure to spread out the work load. The cookers were loaded with raw material or the presses were filled with tankage all at one time and the employees had nothing to do until the cookers were dumped or the presses unloaded. It is economically sound in all rendering plants to spread out the workload. One of the best ways to spread out the workload is through mechanization, permitting a continuous movement of material through the plant.

MARKETING OF RENDERED PRODUCTS

Inedible Tallow and Greases

Production, Yield, and Grades

In 1956, the renderers in Pennsylvania and Minnesota cooperating in this study produced 143 million pounds of inedible animal fats, and slaughterers 32 million pounds (table 21). The value of this fat is estimated at $11 million. This 175 million pounds of inedible tallow and grease was 5.6 percent of the total United States production of 3.1 billion pounds which is valued at an estimated $200 million.

The yield of inedible tallow and grease from the raw material collected varied greatly among renderers owing to the type of material and moisture of the material. All of the rendering plants cooperating rendered more than one raw material and thus the yields should be based on a mixture of all raw materials. A mixture of shop fats and bones yields approximately 25 percent fat and 35 percent tankage. Fallen cattle average from 10 to 12 percent fat and about 24 percent tankage. Much of the metropolitan renderers' raw material is suet or shop fats which may contain up to 75 percent tallow. Thus the yield of fat was equal to the yield of tankage when the productions of all renderers were added together. Solvent extraction plants which can remove all the fat from tankage were included in these yields. Most renderers who collected bones, fat, and a small number of fallen animals blended or mixed the raw material together for rendering and a general consensus showed a yield of 30 percent fat and 30 percent tankage resulted from this raw material. The remaining 40 percent was the moisture which was driven off during the cooking.

The yield of inedible fat from livestock varies greatly depending on size, weight, and age of the animals. From the schedules of those slaughterers reporting who slaughtered only cattle or hogs, the yield of tallow was 39 pounds for each head of cattle slaughtered and 6.3 pounds of inedible grease per hog (does not include lard cracklings). These actual yields are higher than the national averages generally used and may be attributed to several factors, such as more fat trimmed off at the slaughtering plant, more fat going into the inedible rendering cookers rather than edible, and more bones being rendered by the slaughterer from the increasing packaging of boneless meat.

Pennsylvania renderers produced a higher percentage of fancy tallow than those of Minnesota. Pennsylvania renderers had higher grades of raw material to render, such as suet and shop fats, while over half of Minnesota renderers' raw material was fallen animals. The production of yellow grease was high for the renderers of both States (table 20). Much of the yellow grease production resulted from a large amount of poultry offal being rendered. The Pennsylvania renderers produced almost 4 million pounds of brown grease in 1956. A concentration of population in Pennsylvania resulted in a large quantity of "kitchen greases" being collected which were rendered into brown grease. Some small renderers mixed a small amount of these low-grade greases with their light fats causing a lower grade fat to be produced. This practice is inefficient as a small amount of this low-grade grease can lower a large amount of light fat (p. 24).

Table 21.--Production of inedible fat, by grades, Pennsylvania and Minnesota renderers and slaughterers, 1956

TALLOW

Source	Total production 1/	Grades						Total
		Fancy	Prime and extra	Special	No. 1	No. 3	No. 2	
	1,000 lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Renderers:								
Pennsylvania ...	85,827	86	5	7	1	--	1	100
Minnesota	17,473	69	1	8	17	3	2	100
Total	103,300	83	4	5	4	--	4	100
Slaughterers:								
Pennsylvania ...	16,804	76	12	10	--	--	2	100
Minnesota	9,195	93	--	--	--	--	7	100
Total	25,999	83	9	4	--	--	4	100
Total tallow	129,299	83	5	7	3	2/	2	100

GREASE

Source	Total production 1/	Grades						Total
		Choice white	A white	B white	Yellow	House	Brown	
	1,000 lbs.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Renderers:								
Pennsylvania ...	16,769	--	--	38	39	2/	23	100
Minnesota	17,382	2	--	68	28	--	2	100
Total	34,151	1	--	53	34	2/	12	100
Slaughterers:								
Pennsylvania ...	5,730	55	--	13	32	--	--	100
Minnesota	180	--	--	--	--	--	100	100
Total	5,910	54	--	12	31	--	3	100
Total grease......	40,061	9	--	47	33	2/	11	100

1/ Total production of tallow and grease was 174,948,000 pounds, but 5,588,000 pounds produced by renderers was not reported by grade.
2/ Less than 1 percent.

"Since slaughterers have fresh, clean, and uniform raw material it was possible for 85 percent of their finished fat to grade fancy tallow or choice white grease. The remaining 15 percent lower grade fat was rendered from materials of a low grade, such as fallen or condemned animals, catch-basin skimmings, or killing-floor greases" (11, p.17).

Brokers, Exporters, and Direct Sales

Three marketing media are available to renderers and slaughterers for disposing of their inedible tallow and grease: (1) Brokers; (2) exporters; and (3) direct sales to users of animal fats. Most renderers and slaughterers generally sold through one marketing channel, such as a broker. Seventy-one percent of the Minnesota fat production was sold through brokers while only 37 percent of the Pennsylvania production was sold through brokers (table 22). Minnesota renderers and slaughterers tended to sell more through brokers since they were farther from the markets. These brokers kept the renderers in rural areas informed on the market conditions and many renderers valued this service highly. It was the belief of renderers who sold through brokers that they provided some protection against falling markets or no market for fat. Through the continued patronage of the same brokerage company, renderers believed they would have an outlet for tallow and greases even though an overproduction of fat occurred or the demand for export diminished.

Exporters, as such, are a relatively new sales medium for the marketing of animal fats. Most exporters acted as brokers of animal fats until the expansion of foreign markets brought about a need for their services. The difference between exporters and brokers is that the exporters purchase and take ownership of the fat while a broker does not. Some exporters may sell a small amount of their fat for domestic purposes, but generally purchase for overseas shipments. A large amount of the fat purchased by exporters is purchased from brokers. About 9 percent of the Minnesota fat production and 28 percent of the Pennsylvania fat production was sold direct from the renderer to the exporter and the brokerage fee was avoided.

Exportation of fat involves a great risk and the shipment upon arrival must meet the grade standards under which it was purchased. Since most foreign countries do not have facilities for refining tallow it is the responsibility of the exporter to ship high grades of tallow and grease. For these reasons, much of the inedible fat for export must be washed, bleached, filtered, and, in some cases, stabilized. Extensive chemical analyses are taken of the fat by the exporter, importer, insurance company, and the shipping company. Specifications of inedible tallow and greases are shown in table 23.

The direct sale of fat to soap manufacturers, feed manufacturers, and others accounted for 35 percent of the Pennsylvania fat sales and 20 percent of the Minnesota fat sales (table 22). Direct sales of tallow and greases generally arise from long and repeated sales where the buyer knows the quality and grade of fat the renderer or slaughterer produces.

Table 22.--Disposition of inedible tallow and grease by Pennsylvania and Minnesota renderers and slaughterers, 1956

State	Sold direct to users 1/		Sold through brokers		Sold to exporters 2/		Total 3/	
	1,000 pounds	Percent	1,000 pounds	Percent	1,000 pounds	Percent	1,000 pounds	Percent
Pennsylvania...	40,922	35	43,743	37	33,758	28	118,493	100
Minnesota	8,881	20	31,073	71	4,125	9	44,079	100

1/ Direct sales were to soap manufacturers, other renderers, feed manufacturers, and other users.
2/ Exporters purchased direct from renderers and slaughterers for exporting purposes.
3/ Total production was 175 million pounds from Pennsylvania and Minnesota. The 163 million pounds shown is all producers reported.

Inedible tallow or grease is purchased on the basis of a sample which is taken when the buyer gets delivery of the fat. Whether the fat is sold in drums, tank cars, or tank trucks, a sample of each container must be taken and analyzed to determine if the quality meets purchase specifications. Because of unclean or faulty shipping facilities, the quality of inedible fat may deteriorate in transit. Moisture from steam coils or water in the bottom of the tank car tends to break the fat into free fatty acids and glycerine. For this reason, railroad cars, tank trucks, or barrels should be thoroughly cleaned and dried before loading. It is best to have a sample of the fat tested by a recognized laboratory when a sale is made. This service generally costs $10.00 per sample for the following chemical analyses: Titer, F.A.C. color, free fatty acid, moisture and volatile matter, impurities, unsaponifiable matter, and flash point.

The three methods of selling fat, through exporters, brokers, or direct sales, all have individual advantages. The nearness to market, location of plant, grade of fat, type of transaction, size of shipments, and intervals of sales all help to determine the best method of selling for the renderer. In general, a ready market for fat is always available to the renderer who produces a uniform grade and high quality fat.

Premiums and Discounts

Since much of the fat purchased by domestic buyers is used for special purposes, premiums are paid by some purchasers for a high quality of fat. At the present time most large soap manufacturers pay premiums for fat of a low free fatty acid, low M.I.U., and good color. These premiums are flexible and vary slightly between buyers. In order to receive 1/8 to $\frac{1}{4}$ cent per pound premium for his tallow the renderer or slaughterer must produce fancy tallow

Table 23.--Characteristics of inedible grades of animal fats

Fat	Titer (minimum) 1/	F.F.A. (maximum) 2/	M.I.U. (basis) 3/	F.A.C. color maximum untreated and unbleached 4/
	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
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

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.

Fats and Oils Consumption in Prepared Animal Feeds. AMS-252, p. 15. U.S. Dept. Agr., Washington, D. C., May 1958.

of 41.5 titer; free fatty acids of 4 percent; M.I.U. of 1 percent; and a F.A.C. untreated and unbleached color maximum of 7 (13 to 19 Lovibond color). One soap manufacturer has published specifications for a flexible trading basis; and most soap manufacturers and other domestic buyers have similar trading standards. Depending on the ultimate use of the tallow or grease, what one buyer may be willing to pay as a premium another buyer may not. In general, tallow of a free fatty acid content of 2.5 or less, F.A.C. color of 5 (Lovibond color of 12 or less), M.I.U. of less than 1 percent, and a refined and bleached color of 1 can command a premium. Greases of certain grades also warrant a premium, the most important grade factor being that free fatty acid is less than 10 percent.

A discount for tallow and greases not meeting the specifications of the purchase contract is made by purchasers of inedible fats or in some instances, it is rejected by the buyer. The buyer purchases on a specification of grade when the fat is received. Since many renderers and slaughterers do not know the actual grade of their fat and are inclined to think it is the same as the last fat they sold, they may sell tallow and grease believing it to be of a higher grade than it actually is. Also, deterioration in quality may occur in shipping. Rather than rejecting the fat the buyer generally imposes a dockage for fat falling below grade. These dockages vary among purchasers and in many instances fat slightly below grade may not be docked. In general, a dockage will be made if any of the test factors (free fatty acid, M.I.U., and color) are greater than the requirements of that grade but less than the requirements of the next lower grade.

Transportation and Handling Costs

Inedible tallow and greases are sold f.o.b. the buyer. The renderer pays the cost of transportation, weighing, and chemical analysis. The weighing of a tank car costs $10 to $15 and a chemical analysis is usually $10 per sample. If inedible tallow and grease are shipped in barrels or tierces, an additional $\frac{1}{4}$ cent per pound is deducted by the buyer to cover the extra labor involved when the fat is removed from the barrel. Used barrels for shipping fat cost a minimum of 75 cents each and new barrels a minimum of $3.25 each. Barrels generally hold 400 pounds of fat.

For small renderers not having a railroad siding at their plant it is necessary to transport their tallow and grease in barrels by truck or in bulk tank truck. Twenty-nine percent of the total Pennsylvania fat production moved by truck, and 34 percent of the Minnesota inedible fat was transported by truck. The cost of transporting inedible tallow and grease in a tank truck is shown in table 24. A few renderers who used a tank truck of their own reported considerable saving in transportation charges. Some of these renderers who kept the tank truck in continuous operation believed the savings in transportation costs by owning the truck paid for it in a year.

Pennsylvania renderers and slaughterers shipped 71 percent of their fat by railroad tank cars and 66 percent of the Minnesota production moved by rail. The minimum rates for commercial shipments of inedible tallow or grease by rail are shown in table 25. Most of the Minnesota fat production was transported to

Table 24.--Minimum rates for commercial interstate shipments of inedible tallow and grease in tank trucks as of February 15, 1957

Shipments to--	Shipments from--	Minimum rate per 100 pounds 1/ Tallow	Minimum rate per 100 pounds 1/ Grease	Minimum weight
		Dollars	Dollars	Pounds
Pittsburgh, Pa.	New York, N. Y.	0.98	1.05	23,000
Pittsburgh, Pa.	Philadelphia, Pa.	.90	.96	23,000
Harrisburg, Pa.	Philadelphia, Pa.	.55	.59	23,000
St. Paul, Minn.	Chicago, Ill.	1.06	1.06	20,000
St. Paul, Minn.	New York, N. Y.	2.33	2.33	20,000
St. Paul, Minn.	Philadelphia, Pa.	2.33	2.33	20,000
St. Paul, Minn.	New Orleans, La.	2.62	2.62	22,000

1/ These rates are subject to change and do not include transportation tax or accessorial fees.

Source: Government Services Administration

Table 25.--Minimum rates for commercial interstate shipments of inedible tallow and grease by rail, 1957 1/

Shipments from--	Shipments to--	Minimum rate per 100 pounds	Minimum weight
		Dollars	Pounds
Pittsburgh, Pa.	New York, N. Y.	0.72	60,000
Pittsburgh, Pa.	Philadelphia, Pa.	.62	60,000
Harrisburg, Pa.	Philadelphia, Pa.	.40	60,000
St. Paul, Minn.	Chicago, Ill.	.64	60,000
St. Paul, Minn.	New York, N. Y.	1.22	60,000
St. Paul, Minn.	Philadelphia, Pa.	1.22	60,000
St. Paul, Minn.	New Orleans, La.	1.66	60,000

1/ These rates are subject to change, and a transportation tax is not included.

Source: U. S. Dept. Agr., Freight Rate Service Branch.

the East Coast and Gulf ports. Thus, the Minnesota renderer had higher freight costs than did the Pennsylvania renderer when selling fat. The Minnesota renderer had an advantage in freight transportation costs when selling tankage since it was generally sold locally while much of the Pennsylvania tankage was transported to other States. Several renderers were of the opinion that the weighing of tank cars could be improved. Most of these inconsistencies were caused by the coefficient of expansion of fat. Tallow weighs 7.6 pounds per gallon at 60° F. temperature, 2 percent less at 110°, 3 percent less at 135°, and 4 percent less at 160° temperature. An ordinary 32' x 78" railroad tank car, when filled to the dome, should contain a net load of 58,576 pounds of tallow at 60° temperature. If this tank car was loaded to the dome with tallow at 160° temperature, actually only about 56,250 pounds of tallow was loaded in the tank car or 4 percent less tallow by volume. For some renderers who owned their own railroad tank cars and used them as storage tanks, difficulties of the opposite nature arose. Fat was loaded daily into the tank car and allowed to cool. When the tallow was shipped from a cold climate into a warm climate the expansion of the tallow caused the dome lid to be forced open and some tallow was lost.

It is of utmost importance for the renderer to inspect tank cars, tank trucks, or drums for cleanliness before shipping to avoid degrading the tallow. Dirty tank cars and tank trucks should be steamed, washed, and dried before loading. Settlings from previous shipments, leaking steam lines, or moisture can cause the fat to deteriorate.

Uses

There are three common uses for animal fats: Soap making, fat splitting, and addition to livestock feed. The end use of the animal fat produced in Pennsylvania and Minnesota in 1956, where known, is shown in table 26. More of the animal fat in Pennsylvania and Minnesota was sold for use in animal feed than the national average (table 27).

The United States Department of Agriculture has helped to develop and encourage the expanding foreign markets and use of animal fat in feed. Present utilization research is directed toward the use of animal fats in plasticizers, plastics, detergents, and oil additives. Animal fats contain chemical components different from those of vegetable fats,and research in this field appears promising. Other work is directed toward product development and acceptance of animal fats by United States industry and foreign users.

Tankage

The dried residue of animal tissue, tankage, is used for animal feed and fertilizer. Most of the fertilizer tankage is produced from wet rendering. Dry rendering introduced into the United States in 1920 has largely replaced wet rendering. Less than 1 percent of the tankage produced by the renderers and slaughterers of those plants reporting in Pennsylvania and Minnesota was sold as fertilizer tankage. Fertilizer tankage is generally sold on the basis of units of ammonia content. It appears that 10 percent of the dried tankage and 25 percent of the dried blood produced in the United States is used for fertilizer or nonfeeding purposes (5, p.389).

Table 26.--Use of renderers' and slaughterers' inedible tallow and grease in Pennsylvania and Minnesota, 1956

State and type of plant	Total production	Soap	Feed	Export	Fat splitting	Unknown
	Pounds	Percent	Percent	Percent	Percent	Percent
Pennsylvania						
Rendering	108,184,000	23.9	10.3	37.9	2.7	25.2
Slaughtering.....	22,534,000	19.9	1.3	50.2	6.8	21.8
Minnesota						
Rendering........	34,855,000	15.1	10.9	30.3	---	43.7
Slaughtering.....	9,375,000	9.9	34.6	44.0	---	11.5
Total............	174,948,000	20.9	10.6	38.3	2.5	27.7

Table 27.--Disposition of United States inedible tallow and grease, excluding changes in inventory, 1956 1/

Product	Inedible tallow and grease	
	Million pounds	Percent
Exports (net)	1,488	48.6
Soap	813	26.5
Fat splitting	286	9.3
Animal feed	194	6.3
Other products	285	9.3
Total........................	3,066	100.0

1/ Does not include 54 million pounds increase in carryover stocks.

Source: Fats and Oils Situation, No. 183, table 13, p. 28. U. S. Dept. Agr., Agr. Mktg. Serv. April 1957.

The production of tankage is very important to the renderer, although generally it is thought to be a secondary product of rendering. This is not always true, for many times rendering operations are more dependent on the value of tankage than the value of inedible tallow and grease. This is especially true in plants producing tankage of a high protein content, or where the production of tankage exceeds the production of inedible tallow or grease. In 1952, the value of one ton of 60 percent digester tankage was $113, or 5.6 cents a pound, and the average value of tallow was only 5.5 cents a pound (3, p. 213). 11/ During this year many renderers producing a high grade of animal feedstuffs received more return from tankage than from tallow and grease. In 1956, inedible tallow was valued at 6.70 cents per pound while 60 percent digester tankage was valued at $73.68 per ton or 3.68 cents per pound.

Production and Grades

The production of dry rendered tankage from 99 renderers and slaughterers in Pennsylvania and Minnesota was 82,740 tons in 1956 (table 28). Minnesota renderers and slaughterers produced 32 percent of this total. The yield of tankage from raw material varies with the type of material rendered. Slaughterers who rendered only hog or cattle offals reported an average of 6.3 pounds of tankage per hog (not including lard cracklings) and 44 pounds of tankage per head of cattle. These averages are higher than those generally reported for the United States. This higher yield of tankage was probably caused by more fat and bone being trimmed from the carcass at the time of slaughter.

A higher grade tankage (based on percent protein) was produced by slaughterers (table 28). Thirteen percent of the tankage produced by slaughterers graded over 55 percent protein. The two contributing factors to this higher protein tankage were that: (1) Some slaughterers sold their bones and only rendered fats which resulted in high protein tankage, and (2) the tankage from inedible hog offal has a high protein content.

While 69 percent of the Minnesota renderers' meat and bone meal was 51 to 55 percent protein, only 12 percent of the Pennsylvania renderers' production graded this high (table 28). This was the result of a large amount of fallen animals being rendered by the Minnesota renderer and the resulting tankage, which is composed largely of meat tissue, is higher in protein than bone tissue.

Unpressed Tankage

The selling of unpressed tankage by renderers is increasing. It appears that this practice is more prevalent in some sections of the country. Eleven percent of the renderers in this study sold unpressed tankage to other renderers. Two distinct advantages arise from this marketing practice: (1) A small renderer, who does not have a large volume of tankage for pressing saves the

11/ Grain and Feed Statistics Through 1956. Table 93, p. 80. Statistical Bulletin No. 159. U. S. Dept. Agr. Revised, May 1957.

Table 28.--Production of tankage by protein content for Pennsylvania and Minnesota renderers and slaughterers, 1956 1/

Source	Total production	Protein content					Total
		Under 45	46-50	51-55	56-60	Over 60	
	Tons	Percent	Percent	Percent	Percent	Percent	Percent
Renderers:							
Pennsylvania ..	44,363	0.8	87.3	11.8	0.1	---	100
Minnesota	20,590	7.3	23.2	69.0	.5	---	100
Slaughterers:							
Pennsylvania ..	12,035	---	48.5	39.8	8.8	2.9	100
Minnesota	5,752	---	55.8	26.1	18.1	---	100
Total or average	82,740	2.3	63.5	31.1	2.7	.4	100

1/ Does not include wet tankage, unpressed tankage, fertilizer tankage, or feather tankage.

capital investment and operating costs of presses, and (2) the large renderer, buying this unpressed tankage from the small renderer can have a fuller utilization of his pressing facilities, thus lowering his pressing costs per ton. The large renderer can pass part of this savings back to the small renderer by paying a higher price for the unpressed tankage.

Unpressed cracklings from meat and bone material usually contain 30 to 35 percent fat and about 10 percent moisture. (10)

Brokers vs. Direct Sales

Renderers and slaughterers sell tankage (1) direct to feed manufacturers and other users, and (2) through brokers. All of the Minnesota renderers and slaughterers sold tankage direct to feed manufacturers (table 29). Twenty-eight percent of the Pennsylvania tankage was sold through brokers. Many large Pennsylvania renderers and slaughterers located in urban areas did not have a local market. These renderers sold their tankage through a broker. Much of the Pennsylvania tankage was shipped to livestock feeding areas of the Midwest. Pennsylvania renderers shipped 67 percent of their tankage in bulk form (table 30).

Of the 26,342 tons of tankage produced by 27 of the renderers and slaughterers in Minnesota, 39 percent was sold in bulk or in a pressed cake form and 61 percent of the tankage was sold bagged. In Pennsylvania, 72 renderers and slaughterers produced 56,398 tons, of which 57 percent was sold bulk or in pressed cake form and 43 percent of the production was sold bagged.

Table 29.--Methods of marketing tankage, Pennsylvania and Minnesota, 1956

Method of sale 1/	Renderers		Slaughterers	
	Pennsylvania	Minnesota	Pennsylvania	Minnesota
	Number	Number	Number	Number
Direct	29	23	21	4
Through a broker ...	14	--	5	--

1/ At least 90 percent of an individual renderer's tankage (bagged or bulk) was sold direct or through a broker.

Table 30.--Sale of tankage in bagged or bulk form by Pennsylvania and Minnesota renderers and slaughterers, 1956

Form	Renderers		Slaughterers	
	Pennsylvania	Minnesota	Pennsylvania	Minnesota
	Percent	Percent	Percent	Percent
Bagged	33	57	84	74
Bulk	67	43	16	26
Total	100	100	100	100

Uses

Dry rendered tankage, commonly called meat meal, meat scrap, digester or feeding tankage, is sold on the basis of the protein content. Dry rendered tankage of 50-percent protein is generally sold as meat scraps and 60-percent protein as tankage. Both of these feedstuffs have a high feed value and are considered especially good for feeding to swine and poultry. Meat scrap and tankage also contain vitamins, calcium, phosphorus, minerals, and a larger amount of digestible protein than many similar feed supplements.

Research is being conducted on the use of tankage derivatives in adhesives, protective coatings, and resins. The development of these new uses, if successful, should create more demand for tankage.

Other Byproducts

Blood

Fourteen of the 34 slaughterers cooperating in this study dried blood. There were several methods used to dry blood such as a blood dryer, drying in a cooker, mixing the blood with offal, and cooking or mixing hair with the blood and drying. Generally, those slaughterers not drying blood let it run into the sewage system. The production of blood was 1,086 tons for the slaughterers of both States in 1956. Those who mixed blood and hair produced an additional 400 tons of blood. The protein content of the blood varied from 70 to 85 percent or 14 to 17 percent ammonia content and contained approximately 10 percent moisture.

The collection and rendering of blood presented problems for most renderers and only 8.5 percent of the renderers collected blood. Blood collected in drums tended to slosh out when being transported; also, the transferring of blood into the cooker was difficult unless a pump was used, and cooking was a slow process, requiring 6 to 10 hours. The drying of blood, whether in a cooker, blood dryer, or with other animal byproducts is slow and costly owing to the 80 percent moisture which must be evaporated. The approximate cost of the fuel required to dry one ton of liquid blood or 400 pounds of dried blood is $2.62, although this can vary with the type of fuel used. Another problem frequently encountered in drying blood in cookers is the "caking" of blood on the inside of the cooker shell. When the cooker shell becomes "caked" additional time and temperature are required to dry the blood. The addition of ordinary crushed tin cans in the blood helps in keeping the cooker from caking. Dried blood of 10 percent moisture is usually 20 percent the weight of liquid blood.

The value of dried blood in 1956 was approximately $90 per ton bulk and $12 more per ton ground and bagged. Renderers or slaughterers, by mixing blood with offal when cooking, raise the protein content of their tankage, thus indirectly receiving a value for their dried blood.

Glands

Glands for use in pharmaceuticals were sold by 24 percent of the slaughterers visited in both States. Owing to the additional work necessary to remove and prepare glands, very few small slaughterers market glands. The selling of glands is economical only when the volume is large enough to warrant the special handling needed.

Hides

The buying, skinning, salting, and selling of hides present many problems for both renderers and slaughterers. All slaughterers have hides to dispose of (other than hog slaughterers only) and this is done by various means. Some slaughterers sold green hides to tanners, hide buyers, renderers, or other slaughterers. Slaughterers and renderers salting their hides sold them through the same channels or combined their hides with other renderers or slaughterers to sell a carload. Forty-three percent of the renderers in Pennsylvania did not collect any hides but almost all Minnesota renderers collected hides. Some renderers concentrate on the buying, grading, and selling of hides and their hide operation is much larger than their rendering operation. The selling of lower-grade hides such as "country" or "renderer" hides is more difficult than is the sale of hides by packers.

While the outlook for an increased consumption of leather and leather products does not seem favorable, the United States Department of Agriculture is engaged in several research projects to produce leather of a high quality and reduce the labor costs involved in the curing and tanning of hides. The value of cured and tanned leather is from 4 to 5 times the value of a green hide. If suitable methods are found to reduce this high processing margin, it will be possible for leather to compete more favorably with leather substitutes.

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GLOSSARY

Barometric condenser. Used to condense the vapor from cookers.
B. hp. Boiler horsepower.
Blow tank. A large tank in which raw material is collected and then blown by steam pressure into the cooker.
B.t.u. British thermal unit.
Catch basin. A receiving tank for waste water containing baffles designed to separate fat-bearing material from wash water.
Charging. Loading the cooker with raw material.
Charging cart. A wheeled cart used to transport raw material to the cooker.
Color, FAC. The color standard determined by the Fat Analysis Committee of the American Oil Chemists' Society used for grading tallow and grease.
Color, Lovibond. A color reading obtained by matching standard red and yellow color glasses with a sample of color. It is more precise than FAC color.
Color, raw. The color of rendered fat before it is treated to remove or change the color.
Fallen animals. Dead, dying, or condemned animals at the farm or slaughter house.
Fat splitting. The hydrolysis of fat to yield free fatty acids and glycerol.
Free fatty acid (abbreviated F.F.A.). A product resulting when natural fat is broken down in the presence of water.
Fines. Fine particles of bone or foreign material which remain suspended in rendered fat.
Flash point. Determination of the temperature at which a sample of fat will flash if ignited.
Free lance collector. A collector of raw material who has his own sources of collection and sells the raw material to the renderer paying the highest price.
Hasher. A grinder which cuts offal into small pieces by rotating saw blades or knives.
Hog. A grinder which breaks offal into small pieces through rotating "hammers" which push it through a screen.
Hot well. A tank containing condensed water into which the exhaust pipe of the barometric condenser is submerged to reduce offensive odors.
Metropolitan renderer. Collects mainly fat, bones, and offal from city fat sources and less than 10 percent of his total fat production is derived from fallen animals.
Miscella. A mixture of solvent, fat, and fines before they are separated in the solvent extraction process.
M.I.U. The moisture, volatile matter, impurities, and unsaponifiable matter in rendered fat, expressed as a percentage of the weight of fat.
MSCF. 1,000 standard cubic feet (gas).
Peck. A stomach in cattle containing many folds of heavy tissue.
Prebreaker. A grinder which breaks offal into small pieces by crushing it between gears.

Rail. A continuous track suspended from the ceiling on which carcasses can be moved through a plant.

Rural renderer. Collects all types of raw material, but over 10 percent of his total fat production is from fallen animals.

Tankage. Cooked animal material either before or after pressing or extraction.

Titer. An analytical measurement used to indicate the hardness or softness of fat. Tallow has a titer of 40.0° Centigrade and up. Grease is under 40.0° Centigrade.