UTILIZATION OF INEDIBLE BY-PRODUCTS BY SMALL SLAUGHTER PLANTS

by

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INTRODUCTION

The purpose of this study was to gather and analyze information that will assist the operators of small slaughter plants in making more efficient utilization of inedible by-products. The more specific objectives were to study the important regulations affecting the disposal of inedible by-products; determine the proportion of total live weight of hogs and cattle that is inedible; determine the kinds of inedible by-products that can be produced in small plants, and gather information pertaining to inedible rendering for small plants.

In the past many of the small slaughter plant operators have regarded inedible by-products as waste to be disposed of with the least cost. Often the methods of disposal were contrary to the best interests of public health. Regulations have been enacted to eliminate many of the undesirable practices.

The number of small slaughter plants in Kansas has increased rapidly in recent years and apparently is still increasing. This increase is due almost entirely to the expansion in numbers of frozen food locker plants with slaughtering facilities. This increase in the number of slaughter plants suggests the need for economical methods of disposing of inedible offal so as to protect public health, both human and livestock, and also provide a monetary return to the plant operator which can be shared with the customer through lower processing charges and lower meat prices.

LIMITATIONS OF STUDY

This study was confined largely to small slaughter plants and especially those associated with frozen food locker plants. Much of the material gathered also concerns the larger non-federally inspected wholesale slaughterers but in general excludes the large federally supervised packing plants.

There has been some material published pertaining to the utilization of inedible by-products in large meat packing plants, but little has been done to adapt this to the needs of small slaughter plants. The lack of available data and information pertaining to the operation of equipment, governmental regulations, and market outlets made it necessary to gather much of the material for this study through correspondence and personal interview with individuals associated with the meat industry.

Since it was not practical or physically possible to conduct the rendering tests at the Kansas Agricultural Experiment Station, it was necessary to make these tests at small plants which had the necessary equipment. Due to the arrangement of equipment in these plants and the large number of joint operations it was extremely difficult to obtain cost of operation data. Much of the data secured is useful as examples but the number of observations were too few on which to base conclusive observations.

METHODS OF PROCEDURE

The general method of developing this problem was first to present background information such as the importance of by-products to the meat industry, number of slaughter plants in Kansas, regulations affecting the disposal of inedible products, and a survey of present methods of disposal used by small slaughter plants. This material is followed by a discussion of inedible rendering which is the principal process for utilizing inedible offal from slaughter plants. The final section concerns market outlets and value of the inedible products which can be produced in small slaughter plants.

A large portion of the material presented is of a subjective nature and was not readily adapted to statistical analysis. Tables and maps were used extensively to summarize the information gathered.

The principal methods used for gathering information were questionnaires, personal interviews with plant operators and officials in charge of supervisory work, and direct correspondence with equipment companies, officials and other agencies associated with the meat industry.

IMPORTANCE OF INEDIBLE BY-PRODUCTS TO THE MEAT INDUSTRY

The intensive utilization of the waste materials of American industry has been brought about in recent years. Prior to the 20th Century it was unnecessary, from a cost standpoint, to seriously consider the use of these waste materials. This condition was largely due to a bountiful supply of natural resources. With rising costs and increased competition for raw materials it became necessary for industry to consider the processing of waste materials into by-products, in order to keep down production costs of primary products. By-products furnish an opportunity for an individual business, or even an industry, to gain a competitive advantsge by creating new incomes from products previously thrown away. During the early 1900's certain influential men pointed out the fact that our natural resources were not unlimited and further suggested that it would be necessary to conserve the present supply. This activity marked the beginning of a conservation movement that no doubt had a messurablo effect on our industrial development.

Some of the most difficult problems in waste utilization are emphasized in agriculture. There are several requirements upon which the development of agricultural by-products are based. First, there is the necessity of a practical commercial process of manufacture. Second, there must be actual or potential market outlets for the new proposed products. Third, there is need of adequate supplies of the waste used as raw material, gathered in one place or capable of being collected at a sufficiently low cost. Fourth, there is the requirement of cheap and satisfactory storage from crop to crop. Fifth, there is the need of technically trained operatives.[1]

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[1]Clemen, Rudolf A., By-Products in the Packing Industry, (Chicago, Illinois, c. 1927) p. 1.

The large meat packing plants located at the livestock marketing terminals have long been an example of the intensive production of by-products. A common expression is that everything is used but the hog's squeal. The chief purpose of discussing the utilization of by-products in large packing plants is to emphasize the competitive advantage afforded these large plants over the small plants scattered throughout the nation.

The utilization of packing house waste has been brought about through the application of science, especially chemistry and bacteriology, to production methods. With the growth of the packing industry there was a trend toward vertical integration in each plant as they came to recognize the value of by-products. Gradually the various by-product departments were developed and in some cases they might even be referred to as sidelines when outside products such as vegetable oils were brought in for processing.

The exact definition of a by-product is elusive. In general, a meat packer considers as a by-product everything of value produced on the killing floor other than dressed meat. By-products are then subdivided into two divisions: edible and inedible. The edible by-products include such items as hearts, livers, tongues, oxtails, kidneys, and edible fats. The inedible by-products with which this paper is principally concerned may be divided into a number of representative classes:[2]

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[2] Readings on By-Products of the Meat Packing Industry, University of Chicago, (Chicago, Illinois, c. 1941) p. 6.

(1) Products from hair and hides
(2) Products from sinew and blood
(3) Products from inedible offal (viscera)
(4) Products from bones
(5) Pharmaceuticals
(6) Products from inedible fats

Some of the terms used in the discussing of the methods of utilizing inedible materials by slaughter plants should first be defined.

Viscera includes all of the contents of the body cavity both edible and inedible, except blood.

Offal includes everything produced on the killing floor other than the dressed carcass. It includes the viscera plus all other waste parts such as hides, hair, horns, blood, beef heads, oxtails, shank bones, and slaughter room trimmings.

Edible offal includes all offal suitable for use in human food and in general consists of heart, liver, tongue, kidneys, edible gut fats, tripe, weasands, and head trimmings.

Inedible offal includes all remaining parts of the offal after the edible portion has been removed.

Glands refers to those glands useable in the manufacture of pharmaceuticals.

The proportion of the income attributed to by-products by large packing plants varies with different classes of livestock.

Table 1. Proportion of total income from by-products of different species of livestock in large packing plants.1/

	Percentage income from meat	Percentage from all by-products including hide	Percentage income from hide or pelt
Sheep	81.4	18.6	14.5
Steer	87.3	12.7	8.6
Calf	92.8	7.2	Sold with carcass
Hog	96.6	3.4	Sold with carcass

1/ Data from Readings on By-Products of the Packing Industry, University of Chicago, (Chicago, Illinois, c. 1941) p. 10.

The current study has been confined to cattle and hogs, largely because of the small number of sheep actually slaughtered by small slaughter plants in this state. These figures in Table 1 will change somewhat with changing price relationships of the by-products and dressed meat. It should also be pointed out that these figures apply to large terminal packing plants and are presented here first to show the relative value of by-products from different classes of livestock, and secondly to show the importance of this added income in reducing overhead costs of producing the primary product, dressed meat.

It can be seen in Table 1 that the by-products from cattle slaughter are relatively more important than those from hog slaughter with cattle hides making up a large part of by-product returns.

Under normal conditions the returns from the by-products of cattle are almost large enough to offset the operating and marketing expenses of the large packers, including transportation costs from packing plants to retail shops. This means the meat packers, in the long run, will pay the cattle producers all that they get for the dressed beef.[3]

Small slaughter plants marketing their dressed meats locally may have certain advantages over the large terminal packers, such as lower transportation costs, in competing for local sales of meat. However, this advantage could be compensated due to the

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[3]Swift and Company, Agricultural Research Bulletin No. 6, February, 1936, p. 4.

increased efficiency of the large plants in utilizing by-products. Therefore it behooves every small slaughterer to consider ways and means of decreasing operating margins by developing a market outlet for both edible and inedible by-products.

Locker slaughter plants and all other custom slaughterers who slaughter for a fee usually gain ownership to all of the inedible offal except the hide. This material does not cost them anything and in the past has been regarded by too many plants as waste to be disposed of at the least cost to the operator. As competition becomes keener the plant that secures a market outlet for this free material will be in a stronger position to meet this competition. Part of the benefits from income derived from the sale of by-products could be passed back to the patron in the form of lower processing charges and improved service.

NUMBER AND DISTRIBUTION OF SLAUGHTER PLANTS IN KANSAS

Introduction

It will be helpful in this study to get a mental picture of the number and classification of the slaughter plants in the state. For the purposes of this study the plants have been classified on the basis of the type and extent of meat inspection carried on in the plant. Locker slaughter plants will be considered separately at the end of this section.

Federally Inspected Plants

There were 21 federally inspected slaughter plants in Kansas on September 1, 1947.[4] In general they are the large packers located at or near terminal livestock markets. Eleven of the 21 plants are located in Kansas City, four in Wichita, two in Topeka and the remaining four are scattered through the eastern one-half of the state. The Meat Inspection Division of the Bureau of Animal Industry, United States Department of Agriculture, stations veterinarians at the various plants to inspect the animals before and after slaughter. These plants must comply with certain rigid regulations pertaining to physical facilities and methods of handling livestock. The compliance with these regulations and the payment of an inspection fee entitles these plants to market their products through interstate trade.

State Certified Plants

All non-federally inspected slaughter plants in the state are subject to the supervision of the State Board of Health. The official list of slaughter plants issued by the Board of Health in September, 1947, shows a total of 320 state certified plants. This includes 44 plants that are under the state veterinarian inspection plan. In general, these 44 plants are the larger of the 320 state certified plants which slaughter for wholesale and retail markets in Kansas. Several cities require that all meat sold within the city be inspected by a licensed veterinarian.

The number of non-inspected plants has increased from 213 in July, 1946, to 276 in September, 1947. The most important

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[4]Data obtained through correspondence with officials of the Meat Inspection Division.

cause of this increase is the construction of new slaughter plants and especially those in conjunction with frozen food locker plants. Part of the increase may be due the registration of slaughter plants in operation but not registered before 1947. In a study of locker plants in 1946, McKenzie found 14 locker slaughter plants not listed by the State Board of Health.[5] A similar study in 1947 showed 16 locker slaughter plants not on official lists. This explains the discrepancy in figures for the total number of slaughter plants in Kansas on Tables 3 and 4.

Locker Slaughter Plants

The locker industry in Kansas has grown rapidly, especially during the war and the period just after the war. In 1941 there were 185 locker plants in the state. By 1947 the number had increased to 485 plants, Table 2. The growth of the industry has been discussed previously by Otto and Phelps[6] in 1945 and McKenzie[7] in 1947.

The number of locker slaughter plants has increased from a total of 102 to 148 plants during the period 1946 to 1947. This growth can be attributed to two factors, the first, an increase in the total number of locker plants, and secondly, a trend toward a more complete locker plant offering slaughtering facili-

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[5]McKenzie, G. N., "An Economic Analysis of Frozen Food Locker Plants in Kansas with Emphasis on Those Offering Slaughtering Facilities," unpublished thesis, Kansas State College, 1947, p. 33.

[6]Otto, M. L. and Phelps, E. B., "The Locker Plant Industry in Kansas," a mimeographed report. Kansas Agricultural Experiment Station, June, 1946.

[7]McKenzie, G. N., op. cit.

ties. Table 2 shows that the proportion of locker plants in Kansas with slaughter facilities has increased from 27 percent in 1946 to 30.5 percent in 1947. A study of locker plants in the United States made by the Farm Credit Administration in 1947 carries the following statements pertaining to this trend: "To insure better products and make more efficient use of labor and by-products custom slaughtering by locker plants is increasing. . . . Twenty-two percent slaughtered at the plant in 1946 compared with 19 percent in 1943 and 5 percent in 1940."[8]

Locker slaughter plants make up a larger proportion of the total slaughter plants in Kansas for 1947, Table 3. Slaughter plants associated with locker plants made up 34 percent of the total slaughter plants in 1946 and by 1947 this proportion had increased to 41 percent. By referring to Table 4 it can be seen that there were 59 more slaughter plants in 1947 than in 1946. A large part of this incrsase can be attributed to the increased number of locker slaughter plants. It should be pointed out that even though locker plants and other small slaughter plants make up a large percentage of the total number of slaughter plants in Kansas they account for only a small percentage of the total volume of slaughter. The greater proportion of the slaughtering is done in the federally inspected plants.

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[8] Mann, L. B. and Wilkins, Paul C., "Frozen Food Locker Plants," Misc. Report No. 105, Farm Credit Administration, U. S. Dept. of Agr., February 1947.

Table 2. Number of locker plants in Kansas, 1935-1947.

Year	Number of locker plants	Number of locker plants that slaughter	Locker slaughter plants as percent of total
1935 1/	23	---	---
1938 1/	100	---	---
1941 1/	185	---	---
1945 1/	325	---	---
1946 2/	379	102	26.91
1947	485 3/	148	30.52

1/ Otto, Merton L. and Phelps, Ernest B., "The Locker Plant Industry in Kansas," a mimeographed report, Kansas Agricultural Experiment Station, June, 1946, p. 2.

2/ McKenzie, G. N., "An Economic Analysis of Frozen Food Lockers With Emphasis on Those Offering Slaughtering Facilities," Unpublished thesis, Kansas State College, 1947, p. 29.

3/ Data obtained through Dr. G. A. Filinger, Secretary of Kansas Frozen Food Locker Association.

Table 3. Locker slaughter plants as percent of total slaughter plants in Kansas.

	1946 1/		1947 2/	
	Number of plants 1946	Percent of total 1946	Number of plants 1947	Percent of total 1947
Total slaughter plants	296	100	357	100
Locker slaughter plants	102	34.45	148	41.34

1/ McKenzie, G. N., "An Economic Analysis of Frozen Food Lockers with Emphasis on Those Offering Slaughtering Facilities," Unpublished thesis, Kansas State College, 1947, p.29.

2/ Data from survey of locker slaughter plants by questionnaire and personal interview.

Table 4. Number of slaughter plants in Kansas.

	Number of plants		
	1946-47	1947-48	Net gain
Federally inspected1/	21	21	0
State certified plants2/	261	320	+59
State inspected	48	44	- 4
Non-inspected	213	276	+63
Total all plants	282	341	+59

1/ Data obtained through correspondence with officials in Meat Inspection Division, Bureau of Animal Industry, United States Department of Agriculture, 1947.

2/ Data obtained from Evan Wright, State Board of Health, Topeka, Kansas, September, 1947.

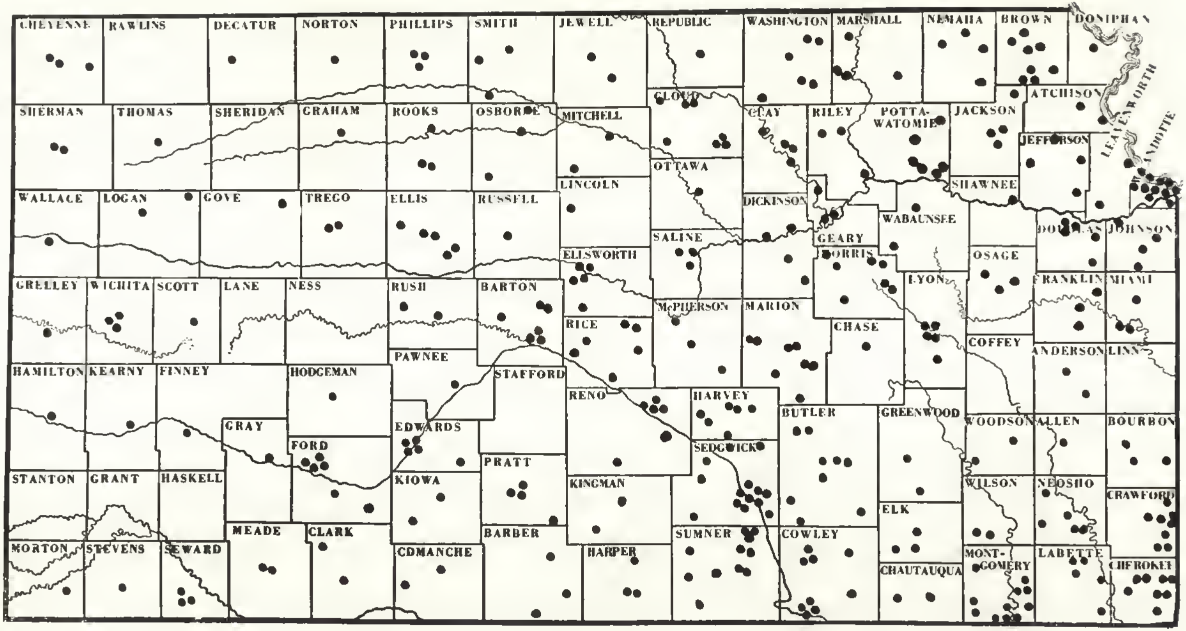

Fig. 1. Non-federally inspected slaughter plants in Kansas, September, 1947.

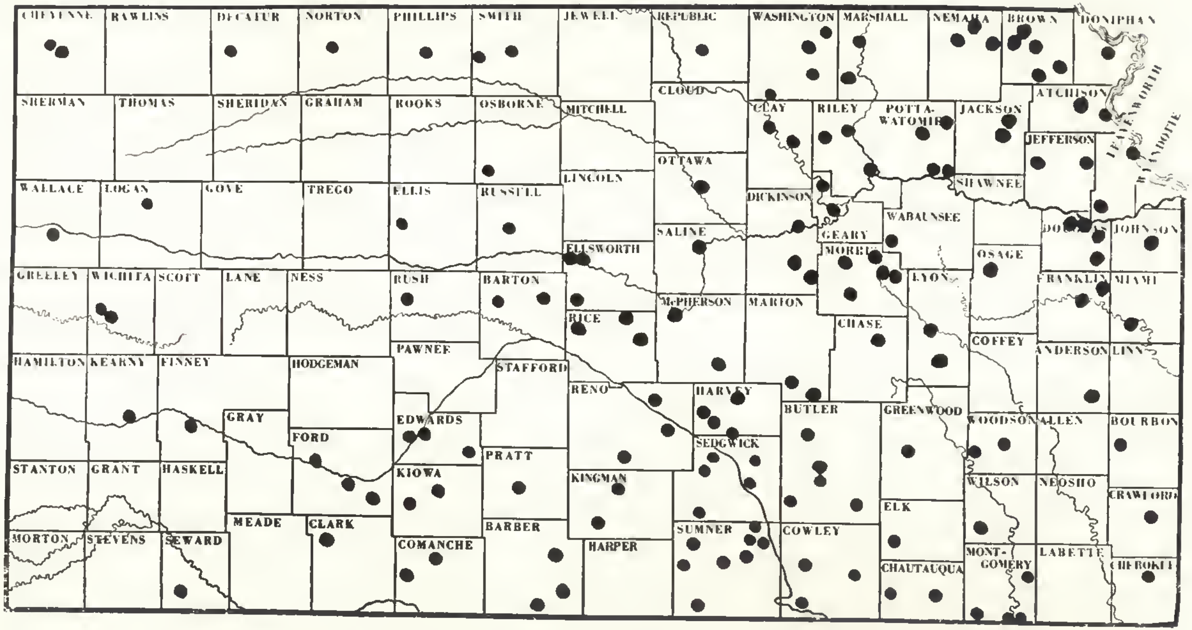

Fig. 2. Slaughter plants associated with frozen food locker plants, September, 1947.

REGULATIONS AFFECTING THE DISPOSAL OF INEDIBLE BY-PRODUCTS

Controlling Agencies

Regulations affecting slaughtering operations and the subsequent processing of by-products must be considered by every operator whether his plant be large or small. The current regulations affecting small slaughter plants will be studied by reviewing the various governmental agencies involved along with a brief discussion of the laws and regulations they enforce. The large packing plants engaged in interstate trade of meats are under federal inspection supervised by the Meat Inspection Division of the Bureau of Animal Industry, United States Department of Agriculture. In general these plants are more closely supervised and regulated than the smaller plants not under federal inspection.

The state agencies that are especially important in the supervision of laws and regulations affecting small slaughtering and rendering plants are the State Board of Health, the State Livestock Sanitary Commission, and the Control Division of the State Board of Agriculture.

State Board of Health

The State Board of Health is charged with the enforcement of The Kansas Meat and Poultry Inspection Act as passed by the state legislature in 1945. The State Board of Health had previously started a program in 1941 to clean up the small slaughter plants in this state. The board adopted and enforced the regulations necessary to bring about improved sanitary conditions in all meat plants. As a result of this action several plants were closed down permanently and others were closed until certain improvements were made. Finally in 1945 most of these regulations were embodied in a new law which is now in effect.

The health of the consuming public is the primary concern of the board of health. Other agencies are concerned with other phases of the sanitation problem.

All slaughterhouses in the state are required to obtain a license which costs ten dollars per year for a packing house or sausage plant, and five dollars for plants who slaughter only and do not process and pack meats for shipment or storage. This includes custom slaughter plants.

The board of health also provides a voluntary system of veterinarian inspection for slaughter plants. This system of inspection finances itself. A veterinarian is employed to make anti-mortem and post-mortem examination of animals and to condemn any diseased animals or damaged portion of the carcass. A small charge is collected by the board of health to pay the veterinarians. Along with his inspection activities the veterinarian stamps all approved carcasses with a stamp showing that the meat is state inspected.

Anyone contemplating the construction of a slaughter plant should first consult the authorities at the State Board of Health. A copy of their regulations and specifications as to physical facilities can be obtained by writing to the Food and

Drug Division, State Board of Health, Topeka, Kansas.

Some of the regulations applying to utilization of by-products are quoted and discussed below.[9]

> Efficient Drainage and Plumbing. There shall be efficient drainage and plumbing system for the establishment, and drains and gutters shall be properly installed with approved traps and vents.

The board of health requires that the blood be trapped on the slaughter floor.[10] They further recommend that each plant should have a grease trap from which the grease is skimmed daily.

> The rooms and compartments of such establishments in which any meat or meat food product, poultry product is prepared or handled or processed shall be free from odor, from dressing and toilet rooms, catch basins, hide cellars, casing rooms, inedible tank and fertilizer rooms, stables, and live poultry feeding or holding rooms.

It is permissible to operate an inedible rendering room in the same building with the slaughter plant; however, it must be separated with a hallway and double doors to prevent the odors from entering the slaughtering and processing rooms.

> Waste Disposal. All offal, blood, garbage, manure or other offensive refuse shall be removed from the premises once every twenty-four hours, if the establishment is operated continuously or if only used occasionally, within twenty-four hours after using. No blood pit, dung pit, offal pool or privy shall remain or be constructed within any such place or establishment nor shall swine be kept or fed within 150 feet of said establishment. All containers used for transporting offal shall be cleaned before they are returned to the plant.

It is permissible to hold offal for more than 24 hours under

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[9] Kansas Session Laws of 1945, Chapter 254, The Kansas Meat and Poultry Inspection Law, 1945.

[10] Interview with Evan Wright, State Board of Health.

refrigeration in a room separate from edible meat products.[11]

Livestock Sanitary Commission

In contrast to the State Board of Health, whose duty it is to protect human health, the Livestock Sanitary Commission, also a state agency, has the job of protecting livestock from disease. Among their many and varied activities is one that is directly concerned with the disposal of inedible by-products from slaughter plants. This agency is directly responsible for the supervision of large rendering plants that collect packing house offal and pick up dead animals. The Rendering Plant Act as amended by the state legislature in 1947 is the basic authority for the commission's supervisory work.[12] The large federally inspected plants under the supervision of the Bureau of Animal Industry, United States Department of Agriculture, are not directly supervised by this commission. At the time of this writing, small slaughter plants who render their own inedible offal and who did not collect offal from other plants, or dead animals, were not directly supervised by this commission.

Many of the small slaughter plants sell their offal to the large rendering companies who are subject to the regulations of the Rendering Plant Act. Some of the small plants may be contemplating the establishment of an inedible rendering plant where dead animals and offal from other slaughter houses could be

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[11] Interview with Evan Wright, State Board of Health.

[12] Kansas Sessions Laws, Article 12, Chapter 47 of General Statutes Supplement of 1945, as amended by House Bill 155, 1947.

rendered along with their own inedible products. Any operation of this nature would be subject to the provisions of the Rendering Plant Act. A copy of this act can be obtained by writing to the Livestock Sanitary Commissioner, Topeka, Kansas. Some of the pertinent parts of this act are quoted below.[13]

> The term "disposal plant" means a place of business or a location where the carcasses of domestic animals or packing house refuse is purchased, received or unloaded and where such carcasses or refuse either (1) are processed for the purpose of obtaining the hide, skin, grease, residue, in any way whatsoever, or (2) are fed to hogs, dogs or other animals.
>
> It shall be unlawful for any person to engage in the business of operating a disposal plant without first obtaining a license from the commissioner. It shall be unlawful for any person to transport or move on a public highway carcasses of domestic animals or packing house refuse, except in a vehicle for which a permit has been obtained from the commissioner. Application for such license shall be made to the commissioner ---. Such application shall be accompanied by a fee of two hundred fifty dollars for each disposal plant.

After the application has been investigated by the commissioner and passed

> ... such applicant shall pay to the commissioner the further and additional sum of fifty dollars for each substation and place of transfer and the sum of twenty-five dollars for each vehicle which said applicant proposes to use in the transportation upon public highways of the carcasses of domestic animals or packing house refuse.
>
> All licenses and permits issued under this act expire on June 30 following date of issuance and must be renewed at that time.

The provisions of the act further specify limitations on the manner of hauling, construction of disposal plants, operations in

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[13] Kansas Sessions Laws, Article 12, Chapter 47 of General Statutes Supplement of 1945, as amended by House Bill 155, 1947.

the plant, and inspection of all plants.

In the past some slaughterers have been known to dump packing house offal in ditches or other places where it has created a public nuisance by polluting streams. The Rendering Act also has a clause to control this situation. The State Board of Health also objects to such action and could file an injunction against the accused for creating a public nuisance.

> Any person or persons who shall put any dead animals, carcasses of such animals or domestic fowl, or any part thereof into any well, spring, brook, branch, river, creek, pond, road, street, alley, lane, lot, field, meadow or common shall be deemed guilty of a misdeamor, and upon conviction thereof shall be fined in a sum not exceeding one hundred dollars.

In a later section of this paper it will be noted that many of the small plants either feed raw offal to their own hogs or allow farmers to pick it up for the same purpose. In strict accordance with the Rendering Plant Act the farmer who is allowed to pick up raw offal from the slaughter plant is required to purchase a $250 annual license plus a $25 permit for the vehicle he uses to pick up this refuse. However, it should be noted that there is no regulation to prevent the pick up of partly processed product, such as wet rendered tankage by the farmer.

The purpose of this section of the law is to discourage the feeding of raw packing house refuse. The Livestock Sanitary Commission is interested in preventing the spread of animal diseases and parasites. Raw hog offal is often contaminated with trichinosis. Trichinosis is a disease caused by the presence of microscopic roundworm parasites in the muscles of human beings, swine and many other animals. One of the chief ways of spreading these parasites is by feeding raw offal or garbage to hogs. The real reason for concern is the effect on humans after consuming improperly cooked pork contaminated with these small parasites. About five percent of the causes result in death and the others in extreme muscular pain and fever. "The average frequency of trichinae in garbage fed hogs is more than six times that in farm raised hogs."[14] Heating to 137° F. will destroy the parasites, therefore a wet rendered tankage is free from trichinae.

Other diseases that may be spread through the feeding of raw offal are tuberculosis and hog cholera. Bovine tuberculosis can be transmitted from cattle to hogs.[15] Therefore the feeding of raw beef offal is one way to spread this disease. Cholera, a highly infectious disease among hogs, can also be spread by the feeding of unprocessed packing house refuse.[16]

The Livestock Sanitary Commission strives to prevent the spread of animal diseases and therefore must discourage the unsanitary practices of feeding raw packing house refuse to hogs or chickens.

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[14] Schwartz, Benjamin, Yearbook of Agriculture, 1942, United States Department of Agriculture, p. 787.

[15] Wright, A. E., Elmer Lash, H. M. O'Rear and A. B. Crawford, Yearbook of Agriculture, 1942, United States Department of Agriculture, p. 237.

[16] McBryde, C. N., Yearbook of Agriculture, 1942, United States Department of Agriculture, p. 673.

Control Division

Almost all of the residues from the rendering of inedible packing house offal are sold as animal feeds such as tankage, meat scraps, and bone meal. All rendering establishments who manufacture and sell these animal feeds will be affected by the regulations pertaining to the sale of these products.

Under Kansas law a manufacturer is privileged to sell any feed that a purchaser may wish to buy so long as it does not contain any ingredient which may be injurious to the health of livestock and poultry, and is registered and truthfully labeled as to items of guaranty and ingredients.[17] The Control Division of the Kansas State Board of Agriculture is the administrative agency that enforces the regulations pertaining to the sale of commercial feed stuffs.

The regulations and their interpretation will be considered briefly in this paper. More complete and detailed information can be obtained by writing to the Control Division at Topeka, Kansas.

Some of the general aspects of these regulations will be pointed out before the actual procedure for registering a feed is discussed. The small slaughter plant with wet rendering equipment is not affected by these regulations as long as the tankage

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[17] Commercial Feeding Stuffs, Report of the Kansas State Board of Agriculture, 64(268):4, August, 1945.

is sold in the wet state just as it comes from the cooker. However, this is no assurance that this situation will continue indefinitely. If the quantity of this material produced and sold by small wet rendering plants should increase sufficiently, regulations pertaining to its sale might become necessary. The small wet rendering plants which produce a dry tankage are subject to regulations explained below.

Another interpretation of the regulations that should be noted is that rendering plants selling animal feeds in bulk lots to large feed mixing companies are not directly subjected to the supervision of the Control Division. The feed mixing company which uses these feeds in compounding mixed feeds must, in turn, register the mixed feed before it is offered for sale in retail channels. Indirectly the small rendering plant will be affected by the regulations.

Essentially the Control Division regulates the sale of finished feed products and is not concerned with the intermediate stages of processing.

Any rendering plant operator who plans to sell a finished animal feed must first register this product with the Control Division. Figure 3 shows a portion of the application for registration. Prior to making an application a chemical analysis must be made to determine the composition of the feed. Such an analysis may be obtained from a commercial laboratory or by sending a sample to the Feeds Laboratory, Department of Chemistry, Kansas State College, Manhattan, Kansas. The Manhattan laboratory is the official testing laboratory for the Control Division.

The costs of these tests range from approximately four to eight dollars depending on the completeness of the test.

The next step is to label the feed correctly. There are definite specifications for the various animal by-product feeds such as digester tankage, meat scraps, and steamed bone meal. These definitions appear in a later discussion on the marketing of inedible by-products.

After the feed has been analyzed and correctly labeled the guaranty must be determined. According to Fig. 3 the minimum protein content, the maximum fat and fiber content, and the percentage of nitrogen-free-extract must appear on the guarantee. It is desirable to guarantee a percentage of feed components that can be maintained consistently. It is also profitable to guarantee as high a protein content for the protein supplements as can be maintained since the value of these feeds are largely determined by the components that appear on the feed tag.

The Control Division employs inspectors to take random samples of feeds being sold in the state. If the content of feed components fails to meet the guaranteed percentage, the distributor is subject to prosecution in accordance with the law.

An inspection fee is assessed to cover the cost of this supervision. The fee may be paid semi-annually by obtaining a permit from the Control Division or by attaching to each bag a fee tag or stamp purchased from the Control Division. The cost is the same under either plan, the current 1947 rate being four cents per ton.

The section ties in closely with a later discussion on marketing of animal by-product feeds on page 115.

_______ Net Wt.

____
(Name of feed)

____
(Name of manufacturer or distributor as shown on label)

________________ ________________
(Town) (State)

GUARANTY

Protein not less than .... _______ %
Fat not more than .... _______ %
Fiber not more than .... _______ %
Nitrogen-free extract .... _______ %

Ingredients:

Fig. 3. Application for commercial feed registration with the Control Division, Kansas State Board of Agriculture, 1947.1/

1/ Taken from feed registration forms provided by the Control Division, Kansas State Board of Agriculture.

Survey of City Ordinances

A survey of municipal ordinances affecting the location of slaughtering and rendering plants was made. An original assumption was that the type and extent of regulations varies somewhat with the size of the city. Therefore, all cities in Kansas were first classified according to size and a stratified random sample of cities with a population of 250 and over were sent questionnaires.

Table 5. A survey of city ordinances affecting slaughtering and rendering plants in Kansas.1/

Population of cities	Number in class	Size of sample	Sample as per-cent of total	Actual number re-turned	Returns as per-cent of class total
Over 100,000	2	2	100	2	100
20,000 to 100,000	3	3	100	1	33
10,000 to 20,000	15	7	47	5	33
2,500 to 10,000	44	12	27	5	11
1,000 to 2,500	78	11	14	5	6
250 to 1,000	292	30	10	6	2
Total	434	65	15	24	5

1/ List of cities and populations obtained from Census of Population, 2(3):142 and 1:406, U.S. Census, 1940.

The returns on all questionnaires from cities of less than 100,000 population were in general incomplete and lacking in details asked for. Due to these difficulties only the more general aspects of city regulations pertaining to the location of slaughter and rendering plants will be considered.

The general trend was for the large cities to have more complete and detailed regulations affecting the location of slaughtering and rendering establishments. There were three types of ordinances in general use, with some of the cities using all three and others only one. These different types of ordinances were (1) specific slaughter ordinances, (2) zoning ordinances, and (3) general nuisance ordinances. All three types of ordinances are used to limit or control the location and operation of slaughtering and rendering plants.

The two large cities, Kansas City and Wichita, use all three types of regulations. In general, zoning ordinances were reported only by cities of 10,000 or more population. The slaughter ordinances were not confined to any particular size of city but a smaller percentage of the towns under 2,500 population reported such an ordinance on their book of statutes, Table 6.

The nuisance ordinances are included in almost all city statutes. This makes it possible for any group of citizens through a signed petition presented to the city officials to declare activities of an individual, or business, a public nuisance. After investigation by city officials the party creating the nuisance can be fined or imprisoned if the conditions causing the nuisance are not corrected. In some cases a business may be closed and forced out of operation if the public opposition is strong enough. The penalties for creating a public nuisance vary in severity ranging from a fine of five to 200 dollars for each day the nuisance remains, or imprisonment from five to 60 days.

Another method of maintaining control over slaughter plants inside city limits was to require them to purchase a license, or permit, every year. In this way the city government could keep a close check on slaughtering operations and if not satisfactory could refuse to issue the license for the next year. This will also tend to discourage small butchers who sometimes do custom work out under a tree or in a shed without proper sanitary facilities. In some cases the city regulations state that a slaughter plant must meet the standards as set up by the State Board of Health before a city permit will be issued. According to state law no slaughter plant or butcher can legally operate without a permit from the State Board of Health, however it would strengthen this state law if the city governments would require a state permit.

Table 6. Slaughtering inside city limits compared with size of city, 1947.1/

Population	Percent with slaughtering or zoning ordinances	Percent permitting slaughter in city
Over 100,000	100	100
20,000 to 100,000	100	100
10,000 to 20,000	60	40
2,500 to 10,000	100	40
1,000 to 2,500	20	40
250 to 1,000	33	17

1/ Data obtained through mailed questionnaires returned from 24 cities in Kansas.

The changes in technique and the improved sanitary facilities of slaughter plants during the past several years have been responsible for some municipalities changing their ordinances so as to permit slaughtering inside the city limits. Some of these original ordinances date back to the early 1900's and a few to the late 1800's when slaughter houses were regarded as highly undesirable in town.

Two cities in the 2,500 to 10,000 population class reported changes in slaughter ordinances so as to permit slaughtering inside city limits. The dates of change were 1944 and 1945. Both cities now have slaughter plants operating in connection with frozen food locker plants inside city limits. One of these plants has inedible rendering equipment in operation. The other slaughter plant is located in the business district and is highly approved by the city official reporting. A third city in this same classification was considering an application to change the present ordinance which prohibits slaughter in the city.

It is significant to note that all 24 municipalities reporting had one or more locker plants. The trend toward a more complete locker plant with slaughtering facilities has already been pointed out. Many of the cities now prohibiting slaughter plants may soon be faced with increased pressure from locker plant operators who desire to add slaughtering facilities to their plant. The State Board of Health has aided some operators in getting local ordinances changed so as to put slaughtering facilities in their plants. However, each case should be judged on its merits. In cities which have adequate sewage disposal, water supply, and power, a city location for slaughter plants is advantageous. By keeping the slaughter inside the city, the city government will have a large degree of control over it; whereas, if the same plant was just outside of the city it might be more difficult to control. Some of the small towns without sewage and water systems might have difficulty with slaughter plants in town unless such a plant would construct an adequate septic tank and water supplying facilities.

One city in the 10,000 to 20,000 class indicated that a slaughter plant would put too much of a load on their sewerage system. This is a limiting factor especially where present sewage facilities are overloaded, however, if blood is trapped, and grease traps are used in the small slaughter plants it should not throw much additional load on the city system.

Regulations in Other States

Some other states have more comprehensive regulations governing the operation of small slaughter plants than Kansas. The growth of the frozen food locker industry has made it necessary for some states to revise their old statutes to meet changing conditions. Both Alabama and Oklahoma have seen fit to make changes and add to their regulations.

The Alabama regulations were put in effect on January 1, 1946. The most significant item concerning the disposal of inedibles is a regulation on inedible rendering which is quoted below.

> Item 35. All offal shall be either rendered under steam pressure until the bones disintegrate or be cooked by boiling until all tendons and muscle attachments are loose, on the day of slaughter, and then be promptly fed to animals or moved from the premises in water-tight containers. No raw offal shall be fed to animals. ... Rendering or cooking, transporting and feeding of offal shall be done in a matter so as not to create nuisance.[18]

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[18]Regulations Governing the Construction, Equipment and Operation of Slaughter Houses, Quick Freeze Locker Plants, and Meat Processing Plants, Alabama State Board of Health, Mimeo. Publication, p. 5, July 11, 1945.

The Oklahoma Frozen Food Locker Plant Act became a law on July 1, 1945. This act is broad and comprehensive with specific regulations pertaining to the construction and operation of locker plants. Item No. 7 deals with the disposal of waste products. This material must be removed from the plant daily or disposed of in an approved manner. Separate chill rooms may be used for the storage of bones, garbage, offal and other waste products if these products are kept in clean metal receptacles. Grease traps are recommended where much grease is discharged into the sewer and special catch basins to catch and retain blood are required in plants where the slaughter house is adjacent to a frozen food locker plant.[19]

It seems reasonable that other states will revise their regulations to provide for greater control of small slaughter plants. There was agitation during the war to put strict limitations on frozen food locker plants. One of the criticisms of these small plants was the inefficient and unsanitary methods of handling by-products and waste materials. If this criticism is true there will be greater control placed on small slaughter plants unless these small operators turn to more satisfactory practices.

Probably one of the first items to get attention will be state sewage disposal laws. It is not the purpose of this paper to analyze sewage disposal problems; however, it has such an important effect on the processing of inedible by-products that

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[19] Oklahoma Frozen Food Locker Plant Act, September 1, 1945.

some of the trends in federal, state and local legislation were considered.

A recent national survey shows a trend toward more effective legislative and administrative action in states to curb pollution of rivers and other streams by untreated sewage and industrial wastes.[20] Plants may have to stop dumping untreated and partly treated waste in streams. Corrective steps in many instances call for major capital outlays. Both Rhode Island and Vermont have initiated legislation to clean up streams by enabling municipalities to enlarge their sewage disposal systems through the imposition of charges against users.

"The growing threat that the federal government will move into the field unless more rapid progress is made by the states has done much, however, to stimulate pressure for anti-pollution action in the states."[21]

Interstate cooperation is already making progress on the Delaware, Potomac and Columbia River basins. Additional projects of this nature are contemplated for other river basins.

It seems likely that even the small slaughter plants in Kansas may be affected by some of these anti-stream-pollution trends, Some of the cities and towns may find it necessary to enlarge sewage disposal plants and if so the chief industrial users may be in for stricter regulation along with an obligation to help pay for these improvements.

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[20] National Provisioner, 117(10):13, September 6, 1947.

[21] Ibid., p. 14.

Fire Insurance Regulations

Most of the small slaughter plants will be interested in some type of fire insurance on their physical facilities. These rates vary widely and are dependent on the fire hazards peculiar to each plant. There is no one rate for slaughter plants built of the same material. The rating schedule is a system by means of which the parts of a hazard in a building may be analyzed and it is meaningless until applied to some actual building. Due to the wide variability of rates each plant should be so constructed and arranged so as to take advantage of the lowest rate that is practical.

The Kansas Inspection Bureau is the authorized rate making organization of the fire insurance companies for Kansas. It is not a department of the State of Kansas. However, the schedules used in rating all kinds of risks must be approved by the Insurance Department which is a governmental agency. The manager of the Kansas Inspection Bureau estimated that 99 percent of the fire insurance written in Kansas takes advantage of the services rendered by this inspection bureau.[22] The bureau is supported by the insurance companies who subscribe to their services.

Some of the more important factors entering into the calculation of fire insurance rates are location of plant, fire fighting facilities of the city, type of construction material, and

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[22] Interview with W. C. Hodges, Manager of Kansas Inspection Bureau, October 1, 1947.

type of business. Other conditions such as clearances for boilers, steam pipes, and rendering tanks will also affect the rate. The actual rate determination will not be discussed.

Slaughter plant owners should go over their plans with the Kansas Inspection Bureau prior to building or remodeling. This precaution should aid in eliminating some of the fire hazards before actual construction begins.

Any plant operator carrying fire insurance with a company who subscribes to the services of the Inspection Bureau may request a copy of the inspection report and the bureau's recommendations for changes which would lower the insurance rate. This report can be obtained by writing to the Kansas Inspection Bureau, 701 Jackson Street, Topeka, Kansas.

Minimum Wage Regulations

The Wage-Hour Act prescribes a minimum wage of 40 cents per hour for employees handling a product which is sold in interstate trade.[23] In almost all cases beef hides from small slaughter plants are sold in interstate trade. Therefore the personnel handling this product in any way are subject to the provisions of the Wage-Hour Act. The same would be true of rendering plant employees if the grease, animal feeds or other products were sold in interstate commerce. The work week is fixed at 40 hours per week by this law. Any overtime work requires pay for time and one-half.

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[23] "The Floor is 40 cents," Business Week, November 6, 1943, p. 90.

PRESENT METHODS OF DISPOSAL FOR INEDIBLE BY-PRODUCTS

McKenzie's Study, 1946

The present methods of disposing of inedible by-products from small slaughter plants has previously been studied. A survey of locker plants that slaughter livestock was made in 1946 by McKenzie.[24] Some of the information found in that survey will be reproduced in this section. Another survey conducted in 1947 among locker slaughter plants resulted in more detailed information pertaining to the disposal of inedible by-products. Additional information was secured through personal visits to some of the slaughter plants.

McKenzie's study showed that the majority of the plants did not have a market outlet for inedible by-products other than to throw them away, feed them to hogs, or give them to rendering firms.

The number of dispositions exceed the number of plants in Table 7 because some plants reported more than one method of disposing of blood and other offal. Of the 51 dispositions, 36 received no returns.

"Most plants reported insufficient volume as the factor prohibiting the installation of a cooker to make tankage and render off inedible grease."[25]

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[24] McKenzie, G. N., op. cit., p. 103.

[25] Ibid., p. 105.

Table 7. Dispositions of blood and viscera in 42 locker slaughter plants, 1946.1/

Disposition	Number of plants
Fed to hogs (no cash returns)	24
Pick-up service (no cash returns)	8
Throw away as waste (no cash returns)	4
Sell to rendering plant	6
Sell to farmers for hog feed	3
Render tankage for resale	4
Render inedible grease	2
	51

1/ McKenzie, G. N., "An Economic Analysis of Frozen Food Locker Plants in Kansas With Emphasis on Those Offering Slaughtering Facilities," unpublished thesis, Kansas State College, 1947, p. 104.

"Schedules of 43 plants reporting disposition indicated that 28 plants sold the hides and credited the patron, one plant purchased the hides from the customer, two plants returned the hides to the patron and 12 plants kept the hide for the slaughtering fee.

"An extremely wide range in prices received for cattle hides existed in 26 plants reporting."[26] These prices ranged from 10 cents to 21 cents per pound.

[26] McKenzie, G. N. *op. cit.*, p. 107.

"The problem of utilizing inedible products is a challenge to the industry. In most cases, operators are aware of the inefficiency; a few plants regard inedible products as animal waste."[27]

Survey of Inedible Disposal in Locker Slaughter Plants, 1947

A survey of slaughter plants was made in September, 1947. Questionnaires were mailed to 116 locker slaughter plants in Kansas followed in two weeks by a tracer to those not yet answering. Forty-nine of the 116 questionnaires were returned in varying degrees of completeness. This represented a return of 42 percent from the original 116 plants contacted.

The purpose of this questionnaire was to obtain more detailed information about methods used to dispose of inedible byproducts in these small plants. In addition to the actual method of disposal, the monetary returns and volume of slaughter were considered. It was assumed that the practices used in locker slaughter plants would be representative of other slaughter plants of similar size. Locker slaughter plants make up 41 percent of the total number of slaughter plants in Kansas, Table 3, page 12.

Sixty-five percent of all plants reporting receive no monetary returns through the use or sale of inedible offal. See Table 8, Disposal of inedible viscera in 49 locker slaughter plants in Kansas, 1947. Twenty-one plants were giving the viscera

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[27]McKenzie, G. N. <u>op</u>. <u>cit</u>. p. 109.

to farmers for hog feed. Another nine plants were giving it to rendering firms just for the pickup service. Two plants indicated that viscera was merely thrown away and did not give further explanation as to the method of disposal.

Table 8. Disposal of inedible viscera in 49 locker slaughter plants in Kansas, 1947.1/

	Number of plants	Percent of total
Picked up by farmer for hog feed, no return	21	43
Picked up by rendering firm, no return	9	18
No use made of viscera, thrown away	2	4
Total plants receiving no returns	32	65
Sells raw viscera to rendering firm	9	18
Feeds viscera to own hogs	3	6
Renders in own plant	3	6
Strips gut fat, no other returns	2	4
Total plants receiving returns	17	35

1/ Data obtained through mailed questionnaire.

Thirty-five percent, or the remaining 17, of the plants received some benefit from inedible viscera. Nine plants, representing more than one-half of the plants receiving returns from inedible viscera, were selling to rendering firms. Only three plants, six percent of the total number reporting, did inedible rendering in their slaughter plants. Three plant operators reported they were feeding the viscera to their own hogs. Two plants were stripping off all gut fats but did not make further use of the inedible viscera.

This survey further emphasizes the need for more efficient utilization of inedible offal in small slaughter plants. Insufficient volume of slaughter has been advanced as the principal excuse for not utilizing inedible by-products. The average weekly volume of slaughter for the winter months was reported by 27 plants. The largest portion of the annual kill is done in the winter months. The average weekly volume of slaughter was calculated for each group of plants reporting a certain disposition of inedible offal. The results were tabulated in Table 9. Average weekly winter volume of slaughter compared with different methods of inedible offal disposal. The total volume of slaughter is expressed as rendering units. A rendering unit was arbitrarily selected to be one cow or one steer. It will take five hogs or five calves to equal one rendering unit. These were based on the quantity of inedible offal produced by each kind of livestock. This will simplify the comparison of volume of slaughter with the different methods of offal disposal.

Sixty-seven percent of the 49 plants reporting indicated that they were receiving a return from the sale and processing of bones. Almost all of these plants were selling bones to rendering firms for prices ranging from one-half cent to two and one-half cents per pound, the average price being one and one-half cents. Two plants were selling bones to dog owners. The two plants with rendering equipment were rendering the bones to recover the grease in them.

Table 9. Average weekly winter volume of slaughter associated with different methods of inedible viscera disposal in locker slaughter plants, 1947. 1/

Methods of disposal	Number of plants reporting slaughter data	Average volume of slaughter: Number of head			Extremes of total	
		Cattle	Hogs	Total 2/	Lower	Upper
No cash returns	19	9	10	11	3	26
Picked up by farmer	12	8	9	10	4	16
Picked up by rendering firm	5	15	15	18	15	26
Some value recovered	8	12	12	14	7	35
Sells to rendering firm	6	12	11	14	7	35
Feeds to own hogs	2	19	14	22	16	29
Renders in plant	2	33	18	37	29	48

1/ Data obtained through mailed questionnaires to locker slaughter plants.

2/ In calculating total, 1 cow = 5 hogs = 5 calves. Based on weight of inedible offal recovered.

Table 10. Disposal of bones in 49 locker slaughter plants in Kansas, 1947.

Disposition	Number of plants	Percent of total
No returns	16	33
Receiving returns for bones	33	67
Selling to rendering firms	29	59
Selling to dog owners	2	4
Render in plant	2	4

In the discussion of regulations of the State Board of Health affecting small slaughter plants, the trapping of blood was mentioned. This agency requires that blood be trapped on the slaughter floor in so far as possible. It is difficult to dispose of blood through sewers and drainage systems because of its tendency to coagulate and clog sewage disposal systems.

It was surprising to find that 19 of the 49 plants reporting dispose of blood by running it down the sewer. This represented 39 percent of the total number of plants reporting, Table 11.

Thirty plants, or 61 percent of the plants reporting, trap blood on the slaughter floor. Eleven plants feed the blood to hogs but did not indicate whether it was raw or partially cooked. Eight plants have the blood picked up by rendering firms. Two of these plants are selling the blood to these rendering firms at one-half cent per pound. Five plants haul the blood away while the three plants with wet rendering equipment add it to their tankage. Three plants did not indicate the disposition made of the trapped blood. One plant sells some of the blood for fish bait.

A surprisingly small number of plants save casings for their own use. Only 2 of the 47 plants reporting were saving casings.

Two plants are saving pancreas glands for sale to a large pharmaceutical house. One of these plants also saves gall. The smaller of these two plants has an annual volume of slaughter of 680 cattle and 80 hogs. The larger plant's annual volume of slaughter is 2,000 cattle and 1,000 hogs.

Thirty-one of the 48 plants reporting, skin hogs. This represents 65 percent of all plants reporting. Only seven plants, or approximately 15 percent of the plants reporting, skin all of their hogs. The remaining 24 plants did not indicate the proportion of hogs slaughtered that were actually skinned. The average weekly winter slaughter of hogs for the 7 plants skinning all hogs ranged from 3 to 15 hogs per week. The mean volume of slaughter for all 7 plants is 9 hogs per week.

The chief means of disposal for hog hides was by selling to hide buyers and rendering firms. The prices ranged from 50 cents to one dollar per hide, the mean price being approximately 75 cents each.

Cattle hides are the most valuable inedible by-product of the slaughtering process. In small plants doing custom slaughter, the ownership and marketing of these hides is handled in several ways as described on page 37. The most common method of handling was to sell the hide and credit the patron.

Table 11. Disposal of blood in 49 locker slaughter plants in Kansas, 1947.1/

Disposition	Number of plants	Percent of total
Run down sewer	19	39
Trapped on slaughter floor	30	61
Feeds to hogs	11	23
Picked up by rendering firm	8	16
Hauled away, no use	5	10
Render into tankage	3	6
Did not indicate	3	6

1/ Data obtained through mailed questionnaire.

The 1947 survey of 48 locker slaughter plants indicated that 37 plants, or 77 percent of those reporting, sold the hides in a green condition. Twenty-one percent of the plants sold cured hides and one plant sold both green and cured hides. The marketing of hides will be discussed in a later section.

The 1947 survey further emphasized the inefficient methods which most locker slaughter plants use to dispose of inedible by-products. The shortage of equipment and skilled labor has contributed to the present situation. However, the operators of small slaughter plants cannot continue to disregard the returns that can be realized from the utilization of inedible raw materials.

INEDIBLE RENDERING

Introduction

Rendering is the separation of fat from tissue and cellular structure by the application of heat. Fat is one of the more valuable portions of an animal carcass. In the inedible department, fats rank second only to hides in value recovered per animal from inedible offal.

There are four different methods of recovering inedible fats in commercial use. The firet method, open-kettle rendering, is used almost entirely for making edible lard and is the oldest procees of the four. It is seldom used for inedible rendering of viscera but may be used for cooking bones.

The second method of rendering is the wet or steam rendering process, also called the digester method. As the name suggeets, the raw materials are cooked in water under pressure.

A third method is dry rendering and is the process ueed by almost all large inedible rendering plants, which is essentislly a melting process.

The fourth and most recent development in inedible rendering is the solvent process. This is a chemical procees and is not as widely used as the other methods, especially dry rendering.

On page three, five basic requirements for the development of agricultural by-producte were listed. Special attention will now be given to the first, which states the necessity of a practical commercial process of manufacture. At the same time it is necessary to consider the third basic requirement, which emphasizes the need of an adequate volume of raw materials gathered in one place, or capable of being collected at a sufficiently low cost.

The last three methods of inedible rendering are discussed with an attempt to evaluate the commercial feasibility for use in small slaughter plants.

Information and data were collected through correspondence and personal interviews with operators of slaughtering and rendering plants. Another source of information was the equipment companies who manufacture and sell rendering equipment.

Wet Rendering

General Description. The primary product to be salvaged by any inedible rendering process is fat. The tankage is also valuable, but secondary in importance when compared to fats.

Figure 4 shows the two basic pieces of equipment for wet rendering, a boiler and a wet tank. The tank, or cooker, is a non-jacketed, vertical, cylindrical steel plate tank having a convex head and cone-shaped bottom to which is attached a large outlet gate valve. A manhole is provided in the top of the tank to receive the raw materials. The sides of the tank are provided with draw-off cocks for draining off the grease.

The animal entrails, bones, and scraps are deposited in the tank through the manhole in the top. When the tank is about three-fourths full the manhole is closed and steam is gradually turned into the tank until a pressure of 35 to 50 pounds is built

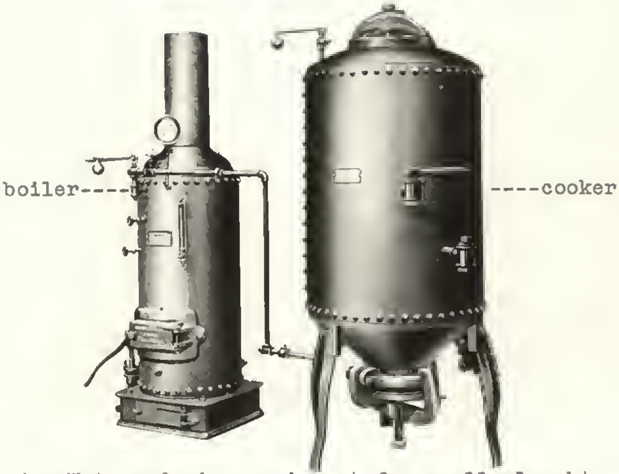

Fig. 4. Wet rendering equipment for small slaughter plants. Boiler and cooking tank.1/

1/ Courtesy Murray Iron Works Company, Burlington, Iowa.

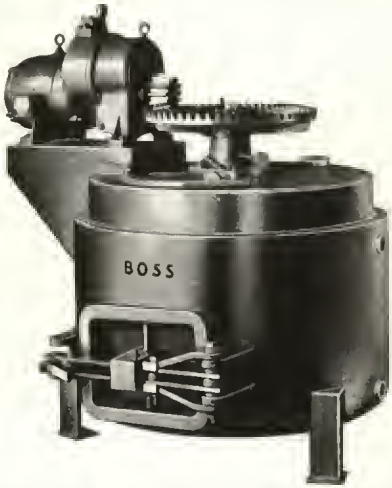

Fig. 5. Vertical drum tankage dryer used in small slaughter plants. 1/

1/ Courtesy Cincinnati Butchers' Supply Company, Cincinnati, Ohio.

up. The tank contents are then cooked at this pressure for 6 to 10 hours, depending on the pressure used and the character of the raw material. At the end of this time the steam valve is closed.

The tank should be allowed to set for at least two to three hours before the internal pressure is relieved. In warm weather it can be left over night. Any internal pressure still in the tank should be released slowly by opening the purge valve at the top of the tank slowly; otherwise the contents of the tank will roll.

During this settling period the contents of the tank will divide into three layers. At the top will be the grease; in the middle will be the tank water or liquid from the raw material plus considerable water of condensation; and on the bottom will be the residue or tankage.

Before drawing off the grease and after the pressure has been released, it is recommended that a handful of salt be scattered on the surface of the cooked material. This aids in the settling of the mass into the three layers.

The grease is then ready to be drawn off. Some of the small plant operators draw the grease directly into barrels; however, most operators run the grease into a settling tank where additional water and foreign material can be removed, which improves the grade of grease.

After the grease has been removed, the tank water is drained off. In most of the small plants this liquid is run down the drain. However, in some plants the wet tankage and tank water are dumped into a curbed-in area on the floor and allowed to settle. Some additional grease may be recovered in this way, but the amount is small. The tank water is usually drained into the sewer. Tank water is rich in nutrients and it has been estimated that 40 percent[28] of the nitrogen in the animal matter treated is contained in this liquid. When this method of rendering is used in large packing plants, a series of huge evaporators are used to reduce the moisture content until the material is a gluey mass called "stick". This stick material is then added to the tankage in the dryers and has the effect of increasing the protein content of the tankage. This equipment is too large to be practicable for small plants. A few operators with small wet rendering tanks are soaking grain in the tank water and using it for hog feed.

The wet tankage or residue left after the tank water has been drained off can be fed to hogs in a wet state, or made into a dry tankage. It can be thrown away, but this is not recommended nor would it be condoned by the local populace.

Wet tankage is a perishable product. In the summer it will sour in a day's time. In the winter it will keep much longer, but here again it depends on the temperature. This wet residue contains about 60 to 70 percent moisture and considerable grease. In large wet rendering plants a rack type hydraulic press is used to reduce the moisture and grease content of this slushy tankage. The pressed material containing from 40 to 50 percent moisture is then put in a dryer where it is reduced to a relatively non-

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[28] Zapoleon, L. B., Inedible Animal Fats in the United States, (Stanford Univ., Calif., c. 1929) p. 87.

perishable product containing from 6 to 10 percent moisture. One operator of a wet rendering plant has a press under construction at a local machine shop. It is generally agreed that it is cheaper to reduce the moisture content of the wet tankage by pressing than by the use of heat. A small press might be desirable where the tankage is to be dried in a dryer such as described below.

Three slaughter plants with wet rendering equipment have installed dryers of different types. The vertical drum dryer pictured in Fig. 5 is a type which is recommended and sold by several companies. One plant operator that installed such a dryer ceased using it and started feeding the wet tankage to his own hogs due to the excessive cost of operation of the dryer. The dryer is a steam jacketed steel drum with an agitator on the inside driven by an electric motor. It takes approximately 6 to 10 hours to dry wet tankage down to a storable product containing 8 to 10 percent moisture. The other type of dryer is a horizontal cylindrical dryer with an agitator rotating within the cylinder.

The equipment used in wet rendering and the general methods of operation have been described. There are certain problems such as what goes in the tank and cleaning of the entrails, that should be considered before studying the size and cost of equipment.

The first step in any rendering process for inedible offal is to clean the entrails and paunchs before loading them into the rendering tank. In small plants this can be done by hand. The entrails should be slashed and washed thoroughly in a curbed-in space in the rendering room. The paunch contents should be carted away. This phase of the process is sometimes neglected by small operators. As a result, the manure, when put in the tank, discolors the rendered fats, reduces the protein content of the meat scraps, and absorbs 7 to 10 percent of its weight in grease.[29] In all of the plants contacted, the caul fats and ruffle fats were removed from the entrails before sending the material to the tanking room.

Bones may or may not be added to the tank. Other market outlets may be attractive, depending on the price of inedible grease. It is possible to recover about 13 percent of the raw weight of bones in the form of grease. If used, bones should be put in the bottom of the tank. They have a favorable effect on the color of the rendered fat, since bones have a tendency to bleach the fat to a lighter color.

Blood should be precooked by running live steam through it until it is about the consistency of liver. Blood has no grease in it but is high in protein and is used to improve the feeding value of the tankage.

Cooking the blood with the rest of the inedibles tends to produce a dark-colored fat; therefore, the recommended procedure would be to add the precooked blood to the tankage after the grease has been drawn off and cook for a short period.

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[29] Readings on the By-Products of the Meat Packing Industry, _op. cit._, p. 103.

Lungs are another material which is useful in tankage but they contain no fat. In fact, they will absorb grease when cooked with the other grease-bearing inedibles. Therefore, it is recommended that lungs either be used for dog food preparation or be added to the tank after the grease has been drawn off and remaining residue cooked for a short period.

Another source of raw material for the tank is the greasy residue collected in the catch basins designed to trap grease before it goes into the sewer, or septic tank. An operator of a large packing plant estimated that a barrel of this material renders out $18 to $20 worth of grease at the current price of 10 cents per pound.

Too much stress cannot be laid upon the quick handling of inedibles in all operations. While in the raw state, bacterial action proceeds rapidly at ordinary temperatures, breaking down the fats into free fatty acids, volatilizing and freeing the nitrogen, thus reducing the protein content of the tankage. A great deal of the odor from inedible rendering can be eliminated by careful attention to sanitary conditions and speed in getting raw material into the tank.

Size and Cost of Equipment. Data pertaining to size and cost of wet rendering equipment were secured from three supply houses. This information is presented in Table 12. The prices listed are an average of three companies' prices and apply at the factory. It is estimated that over one-half of the wet rendering equipment manufactured in the midwest is made by one company which jobs this equipment through several butcher supply firms.

Table 12. Average cost and estimated capacity of wet rendering equipment, 1947.

Cost at factory[2]					Estimated capacity[1]	
Size of tank (gallons)	Cost of tank (dollars)	Size of boiler (horsepower)	Cost of boiler (dollars)	Total cost of tank and boiler (dollars)	Number of sets of inedible offal to fill tank: Cattle	Hogs
150	248	3 1/2	377	625	7	37
225	287	3 1/2	377	664	10	56
300	357	3 1/2	377	734	14	75
400	380	3 1/2	377	757	19	100
500	396	5 1/2	450	846	23	125
600	418	5 1/2	450	868	28	150
700	470	6	491	961	33	175
800	520	6	491	1,011	38	200

1/ Estimated capacity based on yields of 110 pounds of inedible offal per head of cattle; 20 pounds per head of hogs. One gallon of inedible offal weighs five pounds.

2/ Size and cost data secured from three midwest equipment companies.

The smallest wet rendering tank has a capacity of 150 gallons. It would take the insdible offal from 7 cattle, or 37 hogs, to fill this tank to capacity for rendering. However, it is quite possible to operate it when only half full. The gresse can be floated up to a draw-off cock with water. Probably the minimum charge would be the raw materials from 3 to 4 head of cattle, or 15 to 20 head of hogs. This is not to imply that hog and cattle offal cannot be rendered together. In making comparisons between the two it can be assumed that one head of cattle will equal approximately five head of hogs of average slaughter weight. Therefore, the inedible offal from four cattle and ten hogs would fill the tank.

Table 12 lists the size and estimated capacity of wet rendering tanks ranging in size from the 150-gallon tank mentioned above to an 800-gallon tank.

The wet tanks observed in visits to four slaughter plants with rendering equipment varied in size from 300 to 500 gallons.

Almost any type of high pressure boiler could be used to operate a wet rendering tank. The type usually sold with the tanks is a vertical tubular boiler equipped with coal grates. These boilers can be adapted to other fuels, such as gas or fuel oil, with little difficulty.

The capacity of boilers is usually measured in terms of horsepower (H.P.). The size of boiler purchased to operate a wet rendering tank will depend on a number of factors. If the rendering plant is located in the same building or an adjoining building to the slaughter house, a larger boiler will probably be desirable. The size will vary with the number of expected uses for steam, such as cleaning, heating water for scalding, heating the buildings, lard rendering, operating a tankage dryer, etc. For the purposes of this study, the consideration of boilers will be confined to the size required to operate the inedible rendering tank. If a larger boiler is required, the additional cost can be charged to the other phases of slaughtering and processing.

The smallest vertical tube boiler listed with the wet rendering tanks is the 3 1/2 H.P. boiler. Table 12 shows the size of boiler recommended for each size of rendering tank. The 3 1/2 H.P. boiler will handle any tank from 150 gallons to 400 gallons in size.

The vertical drum, steam jacketed tankage dryer is manufactured in three sizes. Size is measured as diameter in feet, or inches. The sizes now offered are the four, five, and six foot dryers. Figure 5 shows a vertical type dryer with an electric motor mounted directly on top. Slightly smaller motors can be used for this type of drive than for the other type which is equipped with a pulley and is driven by an electric motor mounted separately from the dryer. The purpose of the motor is to provide power to turn the agitator inside the dryer. The smallest dryer has a capacity of 300 gallons, or 600 pounds of dry tankage.

The steam requirements for this machine are rather high. The small dryer requires approximately 12 boiler horsepower for normal operation. See Table 13 for capacity data on larger sizes of dryers.

Table 13. Capacity and cost data for vertical drum tankage dryers, 1947.1/

Size, diameter in feet	Estimated capacity: Gallons	Estimated capacity: Pounds of dry tankage	Boiler horsepower required	Electric motor horsepower required	Cost f.o.b. dollars
4	300	600	12	10	1,425
5	450	900	12	15	1,700
6	650	1,300	15	20	1,975

1/ Data obtained through correspondence with equipment companies.

The cost data in Table 12 do not include transportation costs to the place of installation or installation costs. The total cost of boiler and tank is the most significant, since these items constitute the basic equipment for wet rendering. The total cost of these two units at the factory vary from $625 for the 150-gallon tank and 3 1/2 H.P. boiler to $846 for the 500-gallon tank and a 5 1/2 H.P. boiler. In general, the boiler and tank each account for about half of the total cost. The 500-gallon tank marks an arbitrary upper limit to the size of tank adaptable to most small slaughter plants. The cost of transportation and installation will vary widely for different plants due to their geographic location and local situation. An example may shed some light on this problem. A small slaughter plant, 250 miles from the place where the equipment was purchased, reported a total installed cost of $1,500 for a 300-gallon wet tank and a 7 1/2 H.P. boiler. The installation cost amounted to approximately $400. This is probably a maximum figure, since the alteratione and extras added to the equipment were extreme. The boiler was changed over to burn natural gas and was equipped with automatic thermostatic controls as well as an automatio electrio motor-driven water injeotor. This made the boiler fully automatic once the pressure was set and the burner lighted.

The minimum installation charge would be considerably less than this for the same size of equipment. A reasonable minimum installation cost would probably start at approximately $100. These oosts would not include any major building remodeling and assumes that the building, water, and sewage facilities are readily available.

The oost of the various sizes of vertical drum dryers includes the electric motor for all three sizes. Some of the supply housee sell the pulley-driven dryer without the motor, but for the purposes of this study the additional cost of the proper sized motor has been added to the cost of the dryer. The total cost for a four-foot dryer at the factory was approximately $1,425. See Table 13 for costs on other sizes. It should be noted that the dryer is an expensive pieoe of equipment, oosting almost twice as much as the boiler and rendering tank combined.

No attempt was made to secure data on cost of building space used for rendering. This figure could be arrived at only by an arbitrary estimation of value and will vary widely for each plant and the type of construction. If the rendering equipment were located in a separate building from the slaughterhouse, another cost problem would arise and the cost of the building would vary widely with the type of construction. In general, a fireproof building with cement floors is desirable. Plans for such a building can be obtained from some of the butcher supply houses.

Location of Wet Rendering Equipment. An important factor affecting the location of wet rendering equipment is the odor that is produced. There are ways to keep these odors down to a minimum, but as yet there is no way to entirely eliminate them. The chief way to keep down odors is to cook the inedible offal while it is fresh. This recommendation cannot be over-emphasized. Another way to avoid this difficulty is to clean the offal thoroughly and store it in a refrigerated room if the rendering cannot be done the same day and the weather is warm. The containers used should be small enough so the material will cool through to the middle before starting to sour. One operator reported that ordinary garbage cans holding from 25 to 30 gallons were satisfactory. The State Board of Health requires that inedible offal be kept in a separate cooler from edible products.

A mechanical condenser whereby the fumes from the rendering tank are run into a barrel-type container filled with water can be used. This device will condense the water soluble fumes which are run down the sewer.

A chemical supply house has recently put a chlorine deodorant on the market that is supposed to eliminate most of the wet rendering odors. However, no specific information is available as to its effectiveness.

There are about three possibilities in choosing a location to install wet rendering equipment. The first would be to install it in the slaughter building. The second possibility would be to build a separate building closely adjoining the slaughterhouse, and the third possibility would be to install the equipment at a location entirely separate from the slaughter plant, probably outside corporate city limits.

It is more convenient from the standpoint of transporting raw materials to have the wet rendering equipment in the same building with the slaughterhouse. The State Board of Health requires that such a rendering room be separated from the rest of the plant by a passageway and double doors to prevent undesirable odors from circulating through the entire plant. Even this arrangement does not seem to be entirely satisfactory, especially in locker plants and retail plants where patrons pass in and out regularly. While the odor may not be particularly offensive, if all the sanitary precautions are taken, it is objectionable to most people. One locker operator located in town with a grocery store in conjunction with the locker plant reported that he had quit operating his wet rendering tank and plans to move it to the country. This is only one example. There are other locker slaughter plants operating in town with wet rendering equipment, but not without some objectionable odor. During the actual cooking period very little odor escapes if a water condenser is used. However, when the tank is cooked and the material dumped, there is no way to control the odor other than to direct it out of a ventilator in the roof. The odor-laden steam has a tendency to permeate the clothing of the tank-room operator and remain in the clothing until laundered. This makes it necessary for the tank-room operator to change clothes before doing other work in the processing part of a plant, especially if he is to come in contact with customers. Chemical deodorants may be helpful in minimizing this difficulty.

Locating the rendering equipment in a small building connected to the slaughterhouse by a concrete runway will help to keep the odors out of the slaughter plant.

A consideration that is important and may be the deciding factor as to whether inedible rendering equipment may be installed inside city limits is the public reaction to such a proposal and the city regulations pertaining to such plants. This problem was previously discussed in a section pertaining to city ordinances. At least two wet plants in Kansas towns have ceased operation in the period 1946-47 due to the public pressure placed upon them. If a local problem of this nature exists, it would be advisable to contact authorities at the Food and Drug Division of the State Board of Health before attempting to install inedible rendering equipment.

Where conditions are not favorable, a location outside of city limits seems to be the only answer if inedible rendering is to be carried on. There are definite disadvantages to such a location, the most important being the lack of water and sewage facilities. In some cases electricity might not be readily available.

In summary, the most desirable arrangement would probably be to locate the inedible rendering equipment in a small building connected by a concrete runway to the slaughterhouse with the entire combination located at the edge of town, or located in the appropriate zone of larger cities. The distance between the two buildings should be at least 10 feet.

Analysis of Wet Rendering. Two separate tests were conducted to secure information and data on the wet rendering of inedible offal in small slaughter plants. The first test was made on cattle offal and the second on hog offal. The specific objectives were to (1) secure data on the proportion of inedible material resulting from the slaughter of cattle and hogs in small plants; (2) secure information on the operating procedure and the actual yields of grease and tankage from the wet rendering of cattle and hog offal in small plants; and (3) determine the actual returns from the sale of products resulting from the wet rendering of inedible cattle and hog offal. The information obtained is useful as an example of wet rendering results, but should not be used as conclusive evidence of expected average returns in other small slaughter plants. Large variations in rendering yields are due to differences in size and finish of the livestock slaughtered and will be especially variable for cattle. The actual inedible items sent to the tank and the skill of the tank-room operator will cause other variations in yields.

Test on Cattle Offal. The first test was made on cattle offal in June, 1947. Cooperative arrangements were made with the operator of a small slaughter plant. This plant was associated with a locker plant, but also did considerable wholesale slaughtering for local trade. The inedible rendering room was located in the same building with the slaughterhouse. The inedible rendering equipment consisted of a 500-gallon wet rendering tank, a 25-horsepower boiler, a vertical drum tankage dryer, and a water-type odor condenser.

A total of 18 cattle, including both steers and heifers, was used in the test. The average live weight was 838 pounds; all 18 animals came from the same feed lot and were estimated to be of medium to low medium grades. Detailed weights were taken on 11 steers to determine the proportions of edible and inedible products. The killing floor weights showed that 56.3 percent of the live weight of these 11 steers was edible, 25.4 percent was inedible and the remaining 18.3 percent was attributed to shrinkage, waste and other losses, Table 14. The inedible viscera was cleaned for rendering by slashing with a knife in a curbed-in area in the rendering room. The paunch contents were hauled away. The remaining waste material was washed down the sewer with water. The stomach was not thoroughly cleaned; therefore, the cleaned weight of the inedible viscera may be heavier than could normally be expected. The fiber content of the finished tankage was 9.4 percent, which tends to substantiate this observation.

The cleaned inedible viscera minus the lungs and gut fats was loaded directly into the rendering tank. The raw blood was put into the tank without previous cooking. This is not desirable because blood contains no grease and tends to discolor the grease produced from the other material in the tank.

The tank contents were cooked for seven hours at 35 to 40 pounds steam pressure and allowed to cool. The tallow was drawn off directly into 55-gallon steel drums. An average yield of

Table 14. Average yields of slaughter products from 11 steers in a small slaughter plant, 1947.

	Weight pounds		Percent of live weight
Live weight		879.0	100.0
Edible products		495.4	56.3
Carcass weight	461.7		52.5
Edible offal	33.7		3.8
Gut fat 5.8			0.7
Liver, heart, tongue and tail 18.8			2.1
Head trimmings 9.1			1.0
Inedible products		222.7	25.4
Inedible viscera, cleaned	106.8		12.1
Entrails 95.3			10.8
Lungs and spleen 11.5			1.3
Blood1/	23.0		2.7
Shank bones	16.4		1.9
Skull and jaw bones	16.2		1.8
Trimmings	5.0		0.6
Hide	55.3		6.3
Waste, shrinkage and other loss		160.9	18.3
Waste in cleaning entrails	80.7		9.2
Shrinkage and other loss	80.2		9.1

1/ Estimated loss of 10 to 15 pounds of blood due to imperfect trapping facilities.

9.7 pounds of tallow per head was recovered. This is a little low because the tankage, when analyzed, contained 29.77 percent fat which is extremely high even for wet rendering.

The average yield of wet tankage was 71.4 pounds per head, which dried down to 25.3 pounds per head. The wet tankage contained 70.4 percent moisture as it came from the rendering tank, and after drying this was reduced to 5.8 percent moisture. The quantity of dry tankage was estimated to be relatively high due to the incomplete cleaning of the offal.

The yield of tallow per head would have been approximately four pounds higher, making a total of 13.7 pounds, if the shank bones, skull and jaw bones had been added to the tank. This statement is based on an average grease yield of 13 percent on bones reported by one operator who renders bones separately and sells the residue as steamed bone meal.

The gross returns from inedible rendering can be arrived at by multiplying the yields of tallow and tankage by the current prices. The price of grease has fluctuated widely during 1947; therefore, two sets of prices were used. The higher price was 20 cents per pound, and the lower price 10 cents per pound. The tankage price used was $4.00 per hundred, the actual price for which the tankage was sold. Table 16 shows the calculated gross returns from cattle offal. Using the high tallow price of 20 cents per pound, the total returns from tallow was $34.80 with an average return of $1.94 per head. The total returns from tankage at four cents per pound was $18.20, an average of $1.01 per head. The total gross returns was $53.00 with an average return per head of $2.95.

Using a price of 10 cents per pound for tallow, the average gross return per head was $1.98 and the total gross returns

Table 15. Data on wet rendering of inedible cattle offal obtained from a small slaughter plant, 1947.

Description of cattle	
Number of head in test	18
Average live weight, pounds	838
Dressing percent	52.3
Raw materials going to tank	pounds
Cleaned inedible viscera	1,805
Raw blood	414
Total charge to tank	2,219
Weight of rendered products	
Tallow	174
Wet tankage	1,286
Dry tankage	455
Average weight of rendered products	
Tallow	9.7
Wet tankage	71.4
Dry tankage	25.3
Average weight of raw materials not tanked	
Shank bones	16.4
Skull and jaw bones	16.2
Total bones	32.6
Lungs and spleen	10.7

$35.60 for tallow and tankage from 18 head of cattle.

A sample of the dry tankage was taken to the official feed testing laboratory at Kansas State College, Manhattan. The analysis is shown in Table 17.

Table 16. Average gross returns from the wet rendering of inedible cattle offal in a small slaughter plant, 1947.

Actual returns at 1947 prices	
Tallow, 9.7 pounds at 20¢	$1.94
Tankage, 25.3 pounds at $4.00 cwt.	1.01
Total gross returns	2.95
Tallow, 9.7 pounds at 10¢	0.97
Tankage, 25.3 pounds at $4.00 cwt.	1.01
Total gross returns	1.98
Calculated returns at 1947 prices 1/	
Tallow, 15.1 pounds at 20¢	3.02
Tankage, 25.3 pounds at $4.00 cwt.	1.01
Total gross returns	4.03
Tallow, 15.1 pounds at 10¢	1.51
Tankage, 25.3 pounds at $4.00 cwt.	1.01
Total gross returns	$2.52

1/ Tallow yield was increased to include the probable yield of the 32.6 pounds of bones that were not tanked and also to include an additional 2.5 pounds of tallow which could be expected from more efficient operation of the rendering equipment.

Table 17. Chemical analysis of the wet rendered tankage produced in a test on cattle offal.

	Percent
Protein	34.81
Fat (ether extract)	29.77
Crude fiber	9.39
Moisture	5.79
Nitrogen-free extract	9.64
Phosphorus	1.56

Thus it can be seen that the tankage produced is low in protein and extremely high in fat content. In large plants where the stick water is recovered and added to the tankage, the protein content is held around 60 percent and fat content is reduced to less than 12 percent. The high fat content is undesirable because it is more profitable to sell the fat as fat rather than in a tankage.

In conferring with other operators of small wet rendering tanks it was found that it was possible to hold the fat content down around 20 percent with proper operating procedure. This would make it possible to recover an additional 2.5 pounds of tallow per head over and above the 9.7-pound average recorded in this test.

Therefore, the calculated yield of tallow for the cattle used in the test was 15.1 pounds. This includes the expected yield of the 32.6 pounds of bones that were not rendered and the additional 2.5 pounds of tallow that could be expected with more efficient operation of the rendering equipment. See Table 16 for the calculated returns per head.

Test on hog offal. The test on wet rendering of hog offal was conducted at a small slaughter plant during November, 1947. The hogs were slaughtered at one plant and the weights of the edible products were recorded. The inedible offal was hauled to a locker slaughter plant equipped with wet rendering facilities for the actual rendering test. The rendering equipment was located in the rear part of a recently constructed slaughterhouse. The equipment consisted of a 300-gallon wet rendering tank and a 7 1/2 horsepower boiler.

A total of 43 hogs with an average live weight of 280 pounds were used in the test. These hogs had been off feed for 24 hours; therefore, the amount of waste material left in the digestive tract was near a minimum. The proportion of live weight attributed to inedible products and waste was 14.2 percent, Table 18. This was much less than the 47.7 percent recorded in the test on cattle offal. The gut fats were stripped from the viscera. These fats, if removed promptly, can be used in lard rendering. The head bones can be used in making edible products; however, in this case they were trimmed and sent to the inedible rendering tank.

The original charge going to the rendering tank included 757 pounds of inedible viscera, with lungs, caul fat and ruffle fats removed, and 177 pounds of head bones. The total charge for rendering was 934 pounds. The average weight of inedible viscera per head was 17.6 pounds and for head bones it was 4.1 pounds, making a total amount of 21.7 pounds per head to be rendered.

Table 18. Average yields of slaughter products from 43 hogs in a small slaughter plant, 1947.

		Weight pounds		Percent of live weight
Live weight			280.0	100.0
Edible products			240.3	85.8
Carcass weight		222.6		79.5
Edible offal		17.7		6.3
Gut fat	2.4			0.8
Liver, hearts, spleens	5.8			2.1
Head trimmings	5.5			2.0
Feet	4.0			1.4
Inedible products			33.2	11.9
Inedible viscera		20.3		7.2
Blood		8.8		3.1
Head bones		4.1		1.5
Shrinkage and other loss			6.5	2.3

The material in the tank was cooked for nine hours at 35 pounds steam pressure and allowed to cool over night. The grease was drawn off into a settling tank with a steam-heated coil in the bottom. After setting for three hours, the excess moisture and settlings were drained off and the grease removed, weighed, and poured into a barrel. The total weight of grease recovered was 86 pounds, an average of two pounds per head of hogs.

The raw blood and lungs were not added to the tank until after the grease had been drawn off, since neither of these items contain any grease. The blood was first coagulated by running live steam into the barrel for 15 minutes. The lungs weighed 114 pounds, an average of 2.7 pounds per head. The blood weighed 379 pounds, an average of 8.8 pounds per head. The total charge to the tank for tankage cooking, including bones and viscera, was 1,427 pounds, or an average of 33.2 pounds per head.

After the grease was drawn off, the lungs and blood were added to the tank and the entire mass cooked for an additional hour. The steam from the boiler was shut off and the pressure in the cooker was slowly released.

The stick water was drained out of the tank and directed into the sewer. The remaining residue, or wet tankage, was dumped into a curbed-in space on the concrete floor under the cooker where the excess liquid was allowed to drain off. The wet tankage had a total weight of 832 pounds, an average of 19.3 pounds per head; however, it must be remembered that this material contained 68 percent moisture.

A sample of the wet tankage was taken to the feeds laboratory at Kansas State College for analysis. The results are shown in Table 20. In order to make comparisons with other dry tankages the percent of each feed constituent was calculated on a five percent moisture basis for the dry feed.

Table 19. Data on wet rendering of inedible hog offal obtained from a small slaughter plant, 1947.

Description of hogs	
Number of head in test	43
Average live weight, pounds	230
Dressing percent	79.5
Raw materials going to tank for rendering	pounds
Uncleaned inedible viscera	757.0
Head bones	177.0
Total charge to tank for grease	934.0
Lungs	114.0
Blood	379.0
Total charge to tank for tankage	1,427.0
Weight of rendered products	
Grease	86.0
Wet tankage	832.0
Average weight of raw materials per head	
Inedible viscera	17.6
Head bones	4.1
Lungs	2.7
Blood	8.8
Average weight of rendered products per head	
Grease	2.0
Wet tankage	19.3

Table 20. Chemical analysis of the wet rendered tankage produced in a test on hog offal.

	On wet basis percent	On 5 percent moisture basis percent
Protein	10.86	32.00
Fat (ether extract)	6.55	19.30
Crude fiber	0.96	2.83
Moisture	67.75	5.00
Ash	9.83	28.96
Nitrogen-free extract	4.05	11.93
Carbohydrates	5.01	14.76

The same general procedure was used to evaluate the rendering products from hogs as was used in the test on cattle. The price assigned to the wet tankage was one cent per pound, which approximates the market value.

Table 21 shows the calculated gross returns from inedible hog offal. Using the high grease price of 20 cents per pound, the total returns on 43 head of hogs was $25.52, an average of 59 cents per head.

At 10 cents per pound for grease, the total returns would be $16.92 on all 43 head of hogs, which would be an average gross return of 39 cents per head.

Operating Costs. It is difficult to generalize on cost of operation for small wet rendering plants. The cost of utilities will vary widely with the total amount consumed by the plant and the local rate structure. A small amount of cost data was obtained in the two tests on wet rendering. Due to large number of joint operations, it was not possible to isolate many of the operation costs and measure them accurately.

Table 21. Average gross returns from the wet rendering of inedible hog offal in a small slaughter plant, 1947.

Gross returns per head at 1947 prices	
Grease, 2 pounds at 20¢	$0.40
Wet tankage, 19.3 pounds at 1¢ ..	0.19
Total gross returns	0.59
Grease, 2 pounds at 10¢	0.20
Wet tankage, 19.3 pounds at 1¢ ..	0.19
Total gross returns	$0.39

For the purpose of this discussion, costs will be divided into two different classes, fixed and variable costs.

The fixed costs are incurred regardless of the quantity of raw materials processed once the physical facilities have been acquired. They include such items as depreciation on buildings and equipment, interest on investment, taxes and insurance. The investment in building and equipment for the plant at which the cattle offal test was made totaled $3,435, Table 22. The annual depreciation was $177.26, using the straight-line method of calculation. The expected life used in figuring depreciation was 20 years.

Variable costs include fuel, electricity, water, labor, and maintenance or repairs. The total variable costs increase as the quantity of raw materials processed increases.

Labor costs for the wet rendering test on cattle offal amounted to $8.71. The complete process required 13 man-hours of labor and rate of pay in this particular instance was 67 cents per hour.

The fuel and electricity consumption for various sized boilers and electric motors were calculated through the use of an engineer's handbook (see Appendix). The hourly consumption of a 3 1/2 horsepower boiler burning natural gas was calculated to be 195 cubic feet when operated at 50 pounds pressure. The total consumption for an eight-hour run normally required for cooking would be 1,560 cubic feet.

The fuel and electricity consumption was calculated for a 4-foot vertical tankage dryer which requires 12 boiler horsepower and a 10 horsepower electric motor for operation. The average hourly consumption of natural gas was calculated to be 669 cubic feet. The average hourly consumption of electricity by the electric motor was calculated to be 8.78 kilowatts. The total requirement for a 10-hour run of the tankage dryer would be 6,690 cubic feet of natural gas and 87.8 kilowatts of electricity. The actual cost of these materials will depend on the local utility rates; therefore, no value will be attached to them in this paper.

Due to the lack of data, no further analysis of operating costs was made. The figures calculated through the use of data from an engineer's handbook are presented as approximations.

Table 22. Depreciation on wet rendering equipment and building in a small slaughter plant, 1947.4/

Item	Purchase value1/	Annual depreciation2/
	dollars	dollars
Building3/	1,000.00	50.00
Boiler, 25 H.P.	775.00	38.75
Rendering tank (500 gallon)	387.40	19.37
Tankage dryer	990.00	37.00
Electric hoist	219.50	10.98
Dump bucket	58.00	2.90
Odor condenser	37.50	1.86
Tank charging truck	58.00	2.90
Platform scales	20.00	1.00
Total	3,545.20	177.26

1/ All items purchased in 1946.

2/ Straight-line depreciation using expected life of 20 years.

3/ Estimated cost of rendering room as part of slaughterhouse.

4/ Data obtained through personal interview with plant operator.

Actual consumption of fuel and electricity will vary with the quantity and nature of materials rendered.

Dry Rendering

General Description. The dry rendering process was first introduced in the meat-packing industry in 1914. Prior to this time the wet rendering process had been used for edible and inedible rendoring. Since that time, the dry process has largely replaced the wet process in the inedible rendering departments of large packers.

A dry rendering cooker is a horizontal steam jacketed tank with a motor-driven agitator to keep the material in motion during the entire process, Fig. 8. The cooking may be generally described as a melting process. The steam does not come in contact with the raw material but passes through the jacket around the tank. The heat thus supplied is transferred to the material in the cooker, finally evaporating the moisture and melting the fat out of the animal tissues. The cooking and drying are all combined in one process as compared to wet rendering, where two handlings are required. The time required to cook a charge in a dry rendering cooker varies from two and one-half to five hours, depending on the character of the material.

When the batch is finished, the entire mass is discharged into a perculator, which is a steam-heated drain pan, where the excess grease is drained off. This takes from one to two hours. The free grease drains off, leaving the solid residue called "cracklings." the cracklings are pressed in a curb-type hydraulic press for additional grease extraction.

The cracklings come from the press, Fig. 7, in the form of hard, round cakes 1 to 2 inches thick and 12 to 18 inches in diameter, depending on the size of the press. The cracklings can be sold in cake form to feed-mixing firms, or more often they are ground, bagged and sold as meat scraps. Another machine called

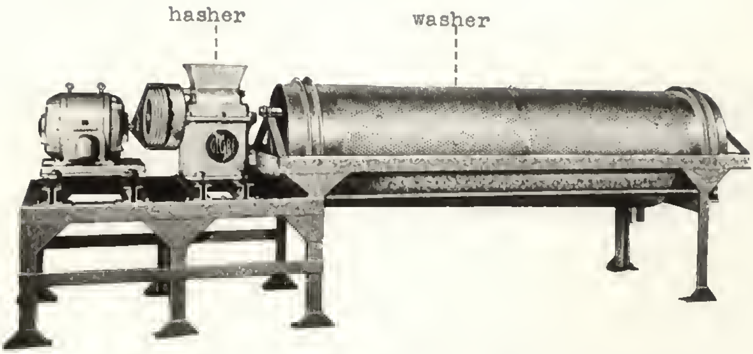

Fig. 6. Hasher and washer used for cleaning viscera in large rendering plants. 1/

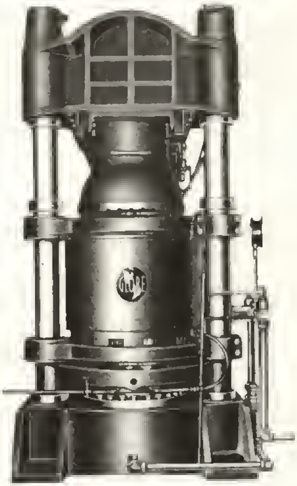

Fig. 7. Hydraulic press used in removing grease from cracklings in dry rendering process. 1/

1/ Courtesy Globe Equipment Company, Chicago, Illinois.

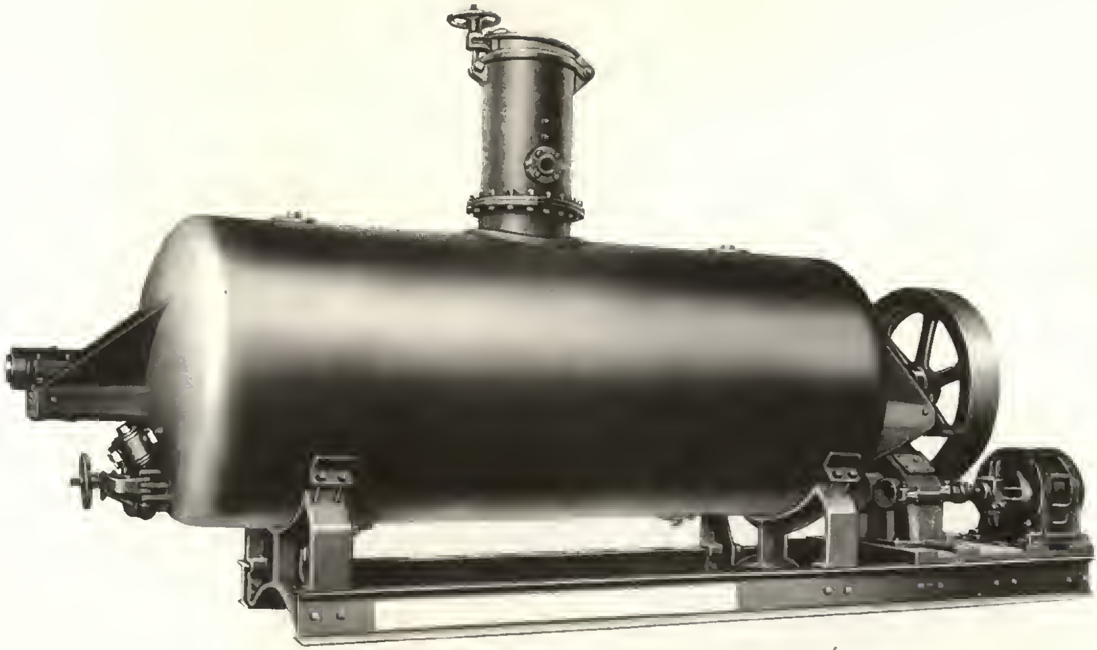

Fig. 8. Dry rendering cooker. 1/

1/ Courtesy Allbright Nell Equipment Company, Chicago, Illinois.

an expeller can be used instead of a hydraulic press to extract grease from the cracklings.

The complete dry rendering process can be completed in about eight hours, which is much faster than wet rendering, where it takes that long just to cook the inedible material.

> A very fine livestock feed is obtained from the dry rendering process, because in dry rendering the material is handled very quickly with little chance of decomposition. The finished product is lighter in color, has no objectionable odor, and has a high protein analysis due to its low moisture and fat content and also because there is incorporated with it all the protein content of the original raw material. The keeping qualities are excellent. For this and many other reasons, the dry rendering process is gradually supplanting the older wet rendering method.[30]

Dry rendering now has widespread use in connection with packing plants and desiccating plants. The chief advantages claimed for dry rendering over wet rendering in addition to the improved product, are that it is a faster process, less odor is produced, and operation costs are less.

Size and Cost of Equipment. The chief reason why small slaughter plants cannot take advantage of the dry rendering process is that the size and cost of equipment limits its use to plants with a fairly large volume of slaughter.

The smallest dry cooker currently being produced by the three large manufacturers contacted has a capacity of 4,000 pounds of raw material. This is the equivalent of 36 head of cattle, or 200 head of hogs. The cookers vary in size from the

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[30] Readings in By-Products of the Meat Packing Industry, op. cit. p. 354.

4,000-pound unit up to 10,000 pounds, which will handle 91 rendering units of raw material, Table 23.

A rendering plant is usually organized around the cooker as the central unit. The larger plants have several cookers in one rendering plant. Since the cooking time required is five hours or less, it is possible to handle 3 to 5 batches in 24 hours during seasons of maximum operation. This makes it possible to process a large volume of raw material with one cooker.

Table 23. Size, capacity and cost of dry rendering cookers, 1947.1/

Size	Electric motor requirements	Boiler horsepower required	Capacity: Pounds of raw material	Capacity: Number of rendering units	Cost f.o.b.
4 x 7	7 1/2-15	20-30	4,000	36	$4,706
4 1/2 x 7	10 -20	20-30	5,000	45	4,000 2/
4 1/2 x 10	15 -25	35-45	7,000	64	4,000 2/
5 x 10	15 -25	45-55	8,000	73	4,830 2/
5 x 12	20 -30	55-65	10,000	91	5,040 2/

1/ Data obtained from the Cincinnati Butcher Supply Company and the Allbright Nell Equipment Company.

2/ Quotation does not include electric motor.

The hydraulic presses, similar to the one shown in Fig. 7, vary in size from 150 tons to 600 tons. The percentage of grease remaining in the pressed crackling varies inversely with the size of the press.

The purchase of dry rendering equipment involves a large initial outlay of capital. The 1947 prices were obtained from one large equipment company through an interview with the sales representative for this territory. The prices on the dry rendering cookers are listed in Table 23.

For the purposes of illustration, the prices from this one company were used in making Table 24, which shows the cost of the various items of equipment for a plant organized around one 4 1/2 x 7 cooker. In general, most companies were rather hesitant to quote equipment prices and emphasized the long list of orders ahead of them.

The two expensive items of equipment are the cooker and the hydraulic press. The total cost of essential items of equipment was found to be \$7,425. This does not include a steam boiler nor the electric motor for the cooker. It is estimated that these items would cost an additional \$1,500, which would raise the total cost of essential items to \$8,925.

The hasher and washer are used to shred the raw material and wash the manure out of it. This can be done by hand in small plants; therefore, this item is not considered to be essential. The other optional item of equipment is the crackling grinder, which would not be used if the pressed cakes of cracklings were sold in cake form. The cost of these two items was \$3,760, which would raise the cost of equipment to \$11,185 if they were installed.

The Meats Department of Texas Agricultural and Mechanical College contemplated the addition of a dry rendering plant to their slaughter plant early in 1947. Correspondence with Mr. Roy W. Snyder, Extension Meat Specialist, revealed that the total cost of equipment would have been \$12,000, including a steam boiler.

The cost of a building and the installation of equipment is difficult to generalize. The Texas plant with the construction of a new building was to have cost $45,000 when completed. The sales representative who furnished the equipment prices for Table 24 estimated that the essential items of equipment for inedible rendering in a slaughter plant could be purchased and installed for approximately $8,000 where the building and boiler were already present.

Dry Rendering Yields. No actual tests were conducted on the dry rendering process. The yields for hogs and cattle of certain weights were furnished by the Allbright Nell Equipment Company and are recorded in Tables 25 and 26. These figures probably represent some of the better results available with dry rendering equipment. The yields of grease and crackling are not directly comparable to the yields under the wet rendering tests since it appears that no blood or bones were used in the dry rendering test. The significant information is the analysis of the cracklings, which in both cases showed a high protein content and a low fat content. This indicates the efficiency of the dry process in recovering inedible grease and also bears out previous statements pertaining to the high quality meat scraps produced.

Solvent Extraction

The solvent process will be discussed only briefly since it appears that present equipment is not adapted to small rendering plants.

In general, the process involves three basic steps. The

Table 24. Cost of equipment for a dry rendering establishment, 1947.[2]

Item of equipment	Price (dollars)
1. 4 1/2 x 7 cooker (5,000 pounds)	4,000
2. Crackling drain pan (6 x 6 x 3)	428
3. Odor condenser	156
4. Hydraulic press, 150-ton	2,120
5. Steam pump for press	521
6. Grease pump	125
7. Tank charging truck	75
Total cost	7,425[1]
Optional items	
1. Hasher and washer - 12 ft. cylinder	1,760
2. Crackling grinder	2,000
Total cost	3,760
Total cost including optional equipment	11,185[1]

1/ Does not include boiler or motor for cooker.

2/ Data obtained from large equipment company, October 21, 1947.

Table 25. Dry rendering yields on 100 steers with an average live weight of 1,292 pounds.[1]

	Pounds
Total weights	
Total weight of material to cooker	8,724
Pressed cracklings	2,704
Tallow recovered	1,658
Average weights per steer	
Weight of raw material to cooker	87
Pressed cracklings	27
Tallow	16.6
Analysis of cracklings	Percent
Protein	58.85
Grease	7.80
Moisture	5.80

1/ Data obtained from Allbright Nell Equipment Company, Chicago, Illinois

Table 26. Dry rendering yields on 490 hogs with an average live weight of 240 pounds.[1]

	Pounds
Total weights	
Total weight of material to tank	6,387
Pressed cracklings	1,467
Grease	765
Average weights per hog	
Weight of material to cooker	13
Pressed cracklings	3
Grease	1.6
Analysis of cracklings	Percent
Protein	61.20
Grease	7.60
Moisture	7.82

1/ Data obtained from the Allbright Nell Equipment Company, Chicago, Illinois.

first is cooking in large horizontal dry cookers and draining off the free grease. Secondly, the cracklings are washed two to three times with a petroleum solvent to remove all but approximately three percent of the grease. This mixture of solvent and grease is then distilled to separate and recover the solvent and the grease.

The chief advantage of the solvent process is the high rate of fat extraction. One of the disadvantages is the difficulty in removing all of the solvent from the cracklings. There is one desiccating plant in Kansas equipped with a solvent system. It is possible for such a plant to reprocess meat scraps or tankage with a high fat content and recover the excess grease.

Rendering Plants in Kansas

The rendering plants in Kansas were divided into three groups for the purposes of this study. These are (1) the licensed desiccating plants, (2) dry rendering plants associated with slaughter plants, and (3) wet rendering plants associated with small slaughter plants.

There were 16 desiccating plants in Kansas in August, 1947.[31] A desiccating plant is a rendering plant that collects dead animals and packing-house offal for processing. These plants are important in this study of small slaughter plants since they provide a means for small slaughter plants to dispose of inedible

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[31]Interview with Walter O. Lentfer, State Livestock Sanitary Commission, Topeka, Kansas, August 4, 1947.

offal. The location of these plants is shown in Fig. 9. The scope of this type of pick-up service will be discussed in a later section on market outlets for inedible products.

All 21 of the federally inspected packing plants are equipped to dry render their inedible offal.[32] Six state inspected plants are now using dry rendering equipment. The six plants are wholesale slaughterers and might properly be called small packers.

According to the best information available, there were six wet rendering plants in operation in December 1947. One of these plants gathers up inedible offal from several other nearby slaughter plants and is, therefore, listed above as a licensed desiccating plant. In the survey of locker slaughter plants conducted in September, three plants reported that they plan to install wet rendering equipment in the near future.

At least six wet rendering plants have ceased operations during the past year. Three of these plants located in town or at the edge of town reported the reason as being adverse public opinion, with one listing unsafe equipment as an additional reason. One operator ceased operations voluntarily because of the undesirable odor created in the building, which also housed his locker plant and grocery store. Another plant operator ceased using his wet rendering equipment because it had become unsafe and is now installing dry rendering equipment.

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[32] Correspondence with the Federal Meat Inspectors at these plants, October 1947.

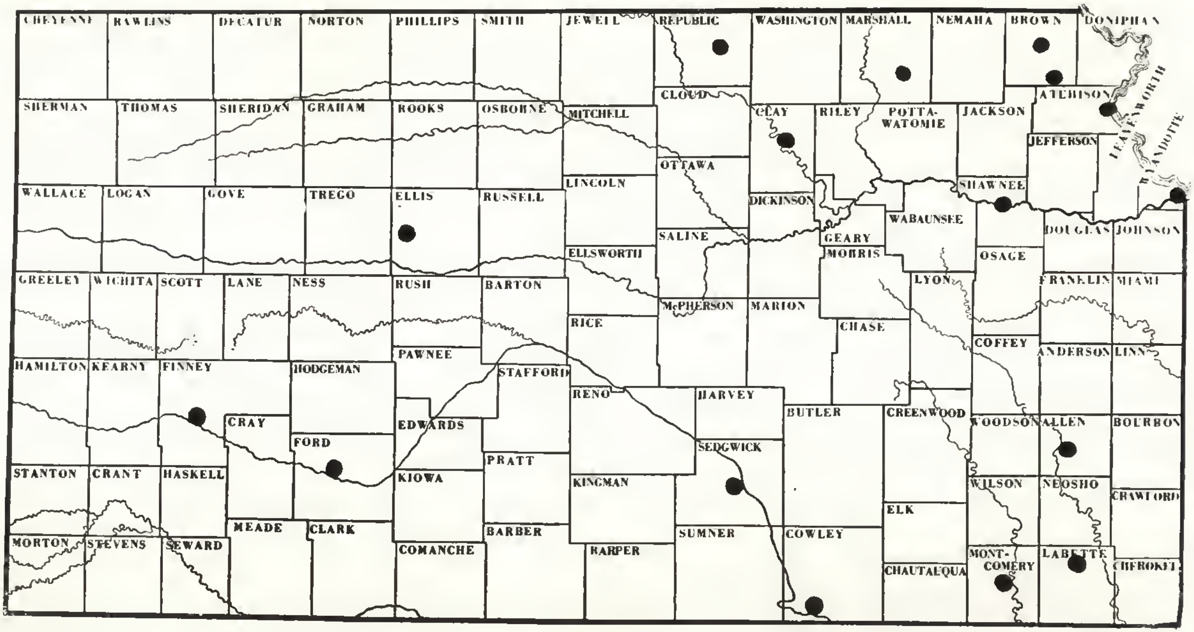

Fig. 9. Licensed desiccating plants in Kansas, 1947. 1/

1/ Data obtained from Livestock Sanitary Commission, Topeka, Kansas.

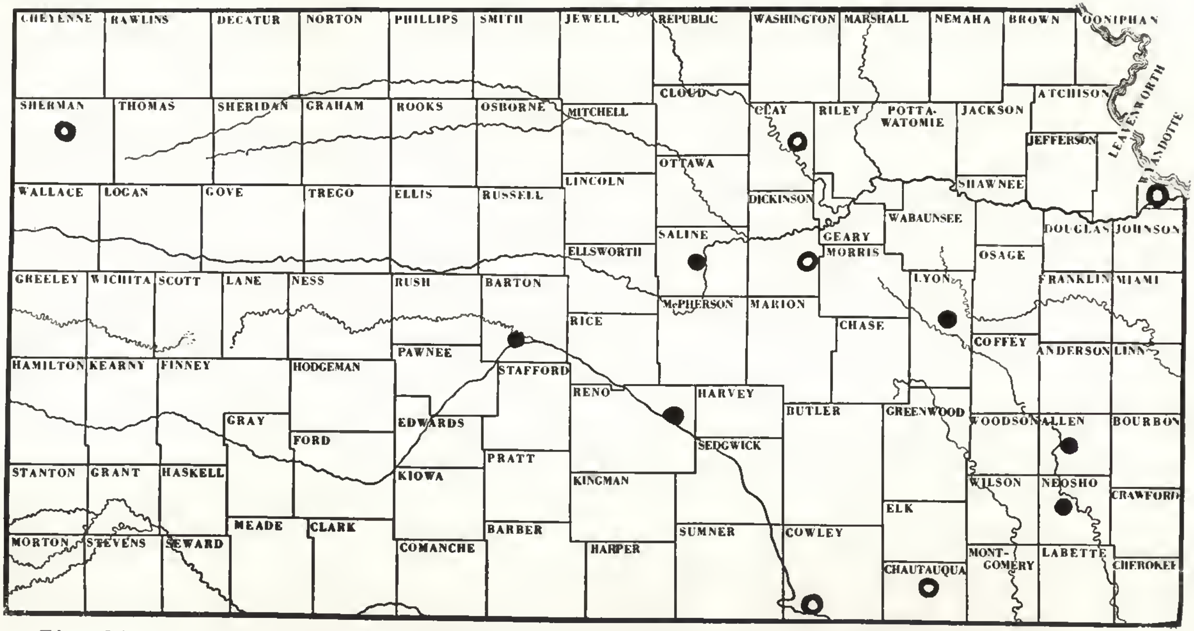

Fig. 10. Rendering plants associated with non-federally inspected slaughter plants, Kansas, September, 1947.

○ -- Wet rendering plants

● -- Dry rendering plants

Volume of Slaughter Required for Inedible Rendering

The two most practical processes for inedible rendering have been discussed at some length. Thus it becomes evident that there are practical commercial processes for the utilization of inedible by-products from the slaughter of livestock. The wet rendering process, even though it has many criticisms, still remains as a commercial possibility for use in small slaughter plants. The dry process, a more recent rendering development, is apparently a superior method for processing inedible offal. However, the minimum economic unit involves larger-scale operations than for wet rendering due to size of equipment and high fixed costs.

This leads to the consideration of the third basic requirement for the development of agricultural by-products which emphasizes the need of an adequate volume of raw materials gathered in one place, or capable of being collected at a reasonably low cost.

In the survey of locker slaughter plants conducted in September 1947, 19 plants reported their estimated volume of slaughter for 1947. Figure 11 is a frequency distribution graph of the number of rendering units of inedible offal produced at these plants. The mean volume of rendering units produced by 19 plants in 1947 was 334. The median of this same group was 280. Q_1 falls at 208 units and Q_3 at 414 units. One large plant with an annual slaughter volume of 990 rendering units tends to pull the average

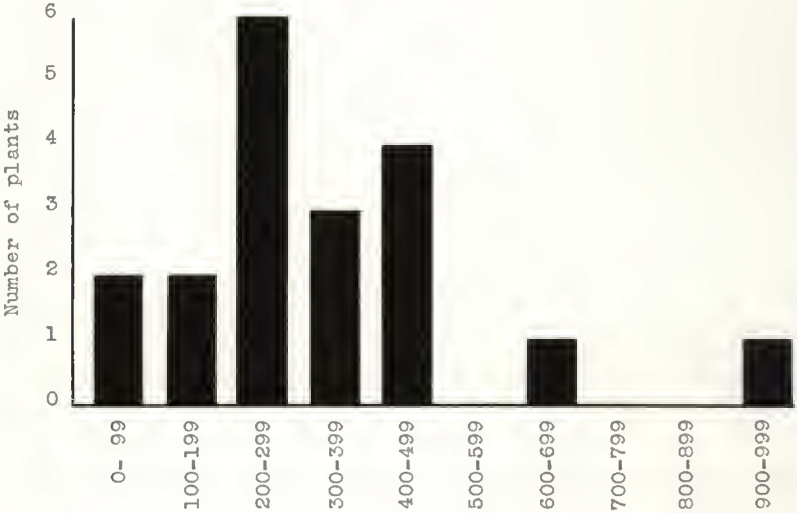

Fig. 11. Frequency distribution of 19 locker slaughter plants in Kansas, based on the number of rendering units of inedible offal produced in 1947.

upward and away from the median.

Another factor that must be considered is the seasonal distribution of this annual volume of slaughter. In the locker industry the tendency is toward a heavy volume of slaughter in the winter with a minimum of slaughtering activity in the summer. It has long been a custom for rural people to butcher, process and store meat during the winter months. The locker industry is striving to educate patrons to the advantages of year-round slaughter and processing service at the locker plant. In this way the locker plants would be insured of a more stable volume of operations, which in turn would simplify labor problems and make it possible to develop a sounder, more efficient program for utilizing by-products.

In the survey of these plants, 32 operators reported their estimated average weekly winter volume of slaughter and the estimated average weekly summer volume of slaughter. These estimations were totaled and summarized as an over-all average for all 32 plants. The average weekly winter volume of slaughter was 12 cattle, 2 calves, and 11 hogs as compared to a summer average of 5 cattle, 1 calf, and 3 hogs per week, Fig. 12. This information was consolidated in Fig. 13 by expressing the total volume of slaughter as rendering units (1 cow = 5 hogs = 5 calves). The estimated average weekly winter slaughter was calculated to be 14 rendering units as compared to 6 rendering units for weekly summer slaughter. By assuming that the year is divided into two six-month periods with October through March representing the winter months and April through September as the summer months, the

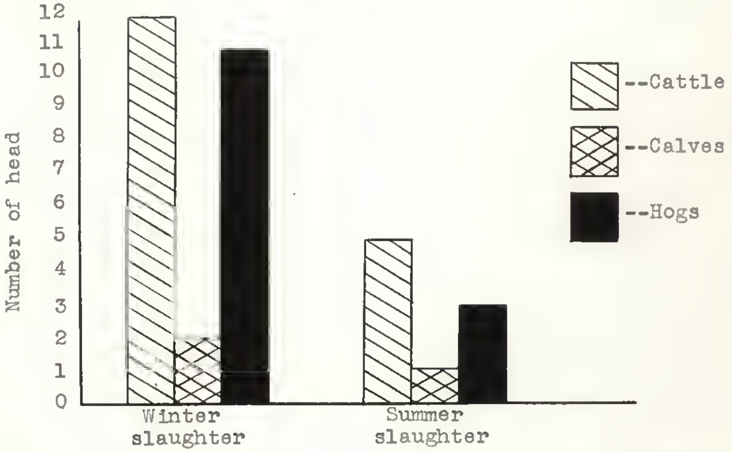

Fig. 12. Average weekly winter slaughter compared to average weekly summer slaughter in 32 locker slaughter plants, Kansas, 1947.

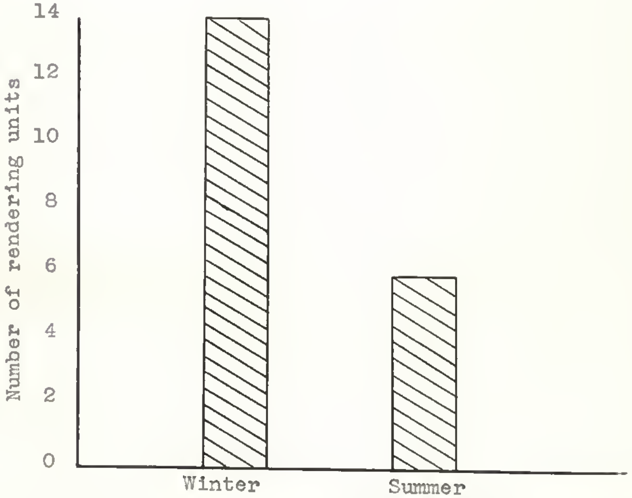

Fig. 13. Average weekly winter slaughter compared to average weekly summer slaughter in terms of rendering units, 32 plants, Kansas, 1947.

winter volume of slaughter would account for 70 percent of the total year's slaughter volume, leaving the balance of 30 percent to the summer months.

Using the smallest wet rendering tank now being made (150-gallon) and loading it only half full, a minimum of three to three and one-half rendering units would be required for one run. Thirty of the 49 locker plants contacted slaughter only on certain days in the week. Therefore, if the summer slaughter could be concentrated on one day in each week, or if it would be possible to refrigerate the inedible offal until a tank load had been accumulated, a plant with a weekly summer volume of slaughter of three to three and one-half rendering units could collect a sufficient quantity of raw materials to warrant the use of a 150-gallon rendering tank. With a seasonal distribution of slaughter as shown in Fig. 13, the average annual volume of slaughter for this plant would vary from 260 to 303 rendering units. Using the ratio as shown in Fig. 12, this would equal an annual volume of slaughter of 217 cattle, 39 calves, and 178 hogs. The average weekly winter volume for a plant of this size would be approximately eight rendering units, which would require two runs of the tank per week.

The median annual volume of slaughter for the 19 plants reporting was 280 rendering units. Therefore, it can be concluded that approximately one-half of the locker slaughter plants have sufficient volume of slaughter to warrant the use of a 150-gallon wet rendering tank, with this conclusion being based on the physical volume of raw materials required to operate a rendering tank the year round.

Where it is possible to do inedible rendering during the winter months of peak operations and dispose of the offal to some other firm during the summer, it would be possible for a plant with an average weekly winter volume of slaughter of only three and one-half to five rendering units to operate a 150-gallon wet tank. At the present high level of grease prices of over 20 cents per pound and with an average yield of 15 pounds per rendering unit, the gross returns from grease sales would be $10.50 per week. At the recent low price level of 10 cents per pound, this gross return would be cut in half to $5.25 per week. At the lower price it is doubtful if there would be any net return over and above the expenses of operation, including both fixed and variable costs. The cost of rendering equipment does not vary directly with the size, Tables 12 and 23. The cost of small equipment is relatively high and the labor required for operation is not much less than for larger units, within reasonable limits. Therefore, the larger plants could reasonably expect larger net returns due to lower fixed costs, and lower labor costs per unit of product. This also applies to dry rendering. There appears to be little reason to doubt that the highest returns are associated with a large volume of operations.

The minimum volume of operations required for efficient dry rendering will be considered briefly since it is apparent that only a few slaughter plants would be large enough to install this type of equipment.

Slaughter data for the first 10 months of 1947 were obtained from the Food and Drug Division, Kansas State Board of Health, for four of the smallest slaughter plants now using dry rendering equipment. The volume of slaughtor for November and December was estimated. The average volume of slaughter for 1947 for these four plants was calculated to be 6,351 rendering units. This is an average weekly volume of 122 rendering units. Two of these plants were visited. The smallest rendering tank in use had a capacity of 5,000 pounds of raw material. By charging this tank at a maximum rate, it would take an average of three runs per week to process this average volume of slaughter. The average weekly slaughter for the month of January was 135 rendering units as compared to an average weekly slaughter in August of 87 rendering units. It would take a minimum of four runs to process the average weekly January volume of slaughter and a minimum of two runs to process the average weekly August volume of slaughter. Both of the plant managers indicated that the inedible rendering department was one of the more profitable packing house operations. Due to the lack of cost of operation data, further discussion on the minimum volume of slaughter required for dry rendering is limited. It is reported by Frank Bilek, Chief Engineer for the Globe Equipment Company, that a dry tank can be operated with as little as 1,000 pounds of raw material or 10 rendering units.[33] Assuming a five-day week for slaughter operations, this would result in a weekly total slaughter of 50 render-

[33] Correspondence with Frank Bilek, Chief Engineer, The Globe Equipment Company, July 24, 1947.

ing units. Tom Waller, Sales Representative for the Allbright Nell Equipment Company, gives a more conservative estimate of a minimum volume of slaughter for dry rendering of 10 to 20 rendering units per day and a weekly total of 50 to 100 rendering units.[34] The average weekly volume of slaughter for the four plants studied falls in this range for the month of August, 1947. Therefore, it might be concluded that these four plants are approaching the lower limit in size of plants that can efficiently conduct dry rendering. It becomes apparent that none of the locker slaughter plants studied have the necessary volume of operations to justify a dry rendering plant. However, the possibility of a joint rendering plant operated cooperatively by a group of small slaughter plants might bring the benefits of the dry rendering process to small plant operators. Perhaps at some future date smaller dry rendering equipment can be manufactured and operated on a profitable basis. At present the equipment companies have large lists of back orders for the larger units and, therefore, did not react favorably to such a suggestion.

Cooperative Rendering Plants

The superiority of the dry rendering process over wet rendering has been stressed. The wet rendering process, while adaptable in size of equipment for approximately one-half of the locker plants, has many disagreeable features. It has been shown

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[34] Personal interview with Waller, Sales Representative, The Allbright Nell Equipment Company, October 21, 1947.

that 65 percent of the locker slaughter plants surveyed receive no returns from inedible viscera. Many of the plant operators interviewed were dissatisfied with the pick-up service offered by large desiccating plants. The joint operation of a rendering plant by operators of small slaughter plants has been suggested many times as a solution to this inedible by-product problem. With such an arrangement, it would be possible to collect a sufficient volume of raw materials to make dry rendering possible. An additional source of raw materials would be dead animals collected from the rural areas surrounding such a plant.

Considerable progress has been made on such a project in Illinois. An extract from a letter received from Frank Gougler, Secretary-Treasurer of the Illinois Cooperative Locker Service, relates the incidents leading up to the present.

> Since 1943, we have built several locker plants in the extreme southern part of the state. The nearest rendering plants were located at East St. Louis and Bellville. The new plants had trouble in disposing of their by-products, therefore keen interest developed in a joint rendering plant. Several meetings were held and plans were made for setting up a plant with an estimated cost of $50,000 including equipment. This movement soon changed the attitude of the rendering people so that these plants could dispose of their by-products at a satisfactory price. Due to this situation and the fact that rendering equipment was not available and building costs were prohibitive at the time, it was decided to delay the project. Our plans were to serve an area within a 50-mile radius from the plant, and it was proposed to render all raw materials from the locker and slaughter plants in the area as well as dead animals. When conditions are more favorable this project will be undertaken.[35]

A similar project has been considered in another area around

[35]Correspondence with Frank Gougler, Secretary-Treasurer of the Illinois Cooperative Locker Service, dated September 26, 1947.

Champaign, Illinois. Several meetings have been held, but the final outcome had not been decided.

At attempt was made to organize a cooperative rendering plant in Kansas in 1946; however, it did not culminate into any material action.

The organization of cooperative dry rendering plants in Kansas at this time would probably be confronted with the same difficulties that are now confronting the Illinois cooperative project, namely, high construction costs and equipment shortages. Also there are several desiccating plants in Kansas that have established pick-up routes for dead animals and packing-house offal. Any attempt to cut in on present trade areas would no doubt face considerable opposition from the established desiccating plants. However, since there is such a large percentage of small slaughter plants which do not realize any monetary returns from their inedible by-products, a cooperative movement on the part of these plants might aid in creating a market for their by-products. Any such move should follow good cooperative organizing procedure. Before any material action is taken, preliminary meetings should be held to acquaint the plant operators with the general aspects of the situation. This should be followed by a survey conducted by committees made up of the plant operators themselves. After the necessary information is gathered, the plant operators can then decide whether a cooperative rendering plant would be desirable. These suggestions on cooperative organization are brief and incomplete; however, the main point to be emphasized is that a development of this type should not be rushed into without careful consideration. A successful cooperative rendering plant must have loyal members who are well informed as to the advantages and limitations of such an organization.

The cost of a dry rendering plant and the necessary building, equipment, including trucks for pick-up service, etc., would vary from $25,000 to $50,000 at present prices. Wet rendering equipment for a small plant would cost approximately $1,000 to install, and if a separate building were necessary, this cost would be even greater. Therefore, if 25 small plants would invest $1,000 in a cooperative dry rendering plant, a large part of the total cost would be accounted for. This example merely indicates the possibilities of pooling the capital that might otherwise be invested in small, relatively inefficient wet rendering plants.

VALUE OF AND MARKET OUTLETS FOR INEDIBLE BY-PRODUCTS

Introduction

It is not within the scope of this paper to give a detailed price analysis of the various inedible by-products. The principal products which small slaughter plants can produce will be discussed chiefly from the standpoint of the market outlets available and the current value of these products. Some of the more important factors affecting market value will be considered.

Hides

Hides are the most valuable by-product of beef slaughter. At the current Chicago price of 28 cents per pound for country hides, the hide from a 1,000 pound steer weighing 60 pounds would be worth $16.80. In general hide weights average about 6.5 percent of the total live weight of cattle and since hide prices have a tendency to equal live cattle prices, the hide actually accounts for about 6.5 percent of the total gross value of the live animal.

Hides and other by-products have peculiar price tendencies largely because they are by-products. Due to this fact, supply fails to react in a prompt and even pattern on demand. An increased supply can only be brought about through increased marketing of livestock. Yet any reasonable price increase for hides would not be expected to cause increased receipts of cattle which are bought primarily for the meat they will produce.

The ultimate market for practically all hides is the tanner who converts the raw hides into leather. The tanners usually obtain their supplies directly from large packers, brokers, or large country dealers. The usual size of purchase is a carload of a certain weight and grade of hides. Therefore, it is almost impossible for a small slaughter plant operator to make direct sales to the tanner.

The hide brokers and commission firms buy up large quantities of hides for the various tanners on a commission basis.

The dealer companies collect hides from local dealers and small slaughterers. This type of organization assembles, grades, trims, stores, and ships hides to the hide brokers, and some of the larger dealers may sell direct to the tanner.

The local buyer operates in a small territory and usually regards his hide-buying activities as a sideline to some other business.

The prevailing market classification of hides divides them into three groups: packer hides, small packer hides, and country hides. The price scale reflects the preference of the tanner for the large packer's hides with slightly less preference for small packer hides over country hides.

Table 27. Spreads between the high price quotations on steer hides for packer, small packer, and country hides at Chicago, December 11, 1947.1/

Hide classes used in calculating spread	Cents per pound	Percentage spread2/
Packer and small packer	3	9
Small packer and country	4	13
Packer and country	7	23

1/ High prices quoted at Chicago were: packer hides 37 cents, small packer hides 34 cents, and country hides 30 cents per pound. Data obtained from National Provisioner, December 11, 1947, p. 53.

2/ Lower priced hides used as 100 percent in calculating percentage spread.

These price differentials are largely due to variations in four factors which enter into hide values. These factors are takeoff, cure, trim, and delivery. The large packer with highly skilled labor can produce a more uniform hide of high quality and as a result receives a premium for it. These four factors will be considered from the standpoint of how a small slaughterer can improve the quality of his hides and market them at prices approaching the small packer's price level.

Hide take-off is probably the point that should receive the most attention in a hide improvement program. After a hide is cut or deeply scored, nothing can make it a number one hide. The pattern of hides desired by the tanner is standardized. Any other take-off pattern will be discounted in price. The small operator should make every effort to see that the skinner is equipped with the proper knives and is following the standard take-off pattern. With proper equipment and technical knowledge, only practice will develop the skinner's skill. Detailed information on hide take-off and treatment is available through the United States Department of Agriculture or the American Meat Institute.

Hides are usually preserved by salting down in a hide room or cellar where they are cured over a period of approximately 30 days. During this time the average hide will shrink 15 percent, with a maximum shrink of about 20 percent, varying with the length of time in cure.[36] Most of this shrink will occur in the first

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[36]<u>Readings on By-Products of the Meat Packing Industry</u>, <u>op. cit.</u> p. 24.

seven days.[37] Hides are usually accumulated for at least a month and at the end of that time, if the market situation is desirable, bidders are invited to make offers on the hides in stock. The hide dealers who purchase the hides recover some of the weight lost in curing by soaking the hides in a brine.

Hides should be trimmed before salting. This consists of trimming off switches, ears, snounts, dewclaws and excessive meat and fat. This material is of no value on the hide and will be a point on which the bidder can dock the hides. The tanner prefers a standard trim since it reduces handling and processing costs.

Delivery pertains to the shipping procedure used. With small operators this will not be much of a problem since hide buyers will usually come to the plant to pick up the hides. In larger plants, when the hides are taken out of the salt cure, they must be shaken over a frame to remove excess salt. The buyer then inspects the hide and agrees on a grade with the seller. The hide is then folded and tied in a neat bundle about one foot square and loaded on the truck or car for shipment.

The small slaughterer should pay particular attention to at least three of these factors, namely, take-off, cure and trim.

Almost all of the locker slaughter plants contacted sell their hides to country dealers who pick up the hides at regular intervals. The prices paid by these dealers tend to be an aver-

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[37]Snyder, Roy, Extension Meat Specialist, Texas Agricultural and Mechanical College, Remarks at Slaughter Clinic, National Frozen Food Locker Conference, Kansas City, Missouri, September 23, 1947.

age price and, therefore, any improvement in quality of hides by a small operator might not be reflected in the price he receives. If the slaughter plant is within the trade territory of two buyers or if the number of hides produced is large enough to attract buyers, there is good opportunity to command a price premium for high quality hides.

A prominent locker operator stated in an interview that he found it very profitable to cure hides and sell them on a graded basis. In 1946, this plant slaughtered 874 head of cattle and calves. The grading merely consists of putting the number one hides in one pile and the number two's, which are the cut or damaged hides, in another pile. This operator also believes in keeping well posted on current hide prices through appropriate market news publications.

The manager of a large company which buys hides from small slaughter plants in Kansas was interviewed in an effort to gain information on their pricing methods and volume of business. All of the hides are bought as country hides, the base price being quoted on salted trimmed hides. Salted untrimmed hides are one cent less per pound and unsalted untrimmed hides are bought at a two-cent-per-pound discount. The volume of hides handled in winter months was estimated to be 5,000 hides per month. The hides are graded, sorted into lots and soaked in brine to recover weight in the cured hides. The hides are sold to tanners or wholesale buyers in lots of 1,000 or more.

In the mailed questionnaire to locker slaughter plants, only 8 of the 37 plants reporting sold cured hides. Twenty-nine plants or 78 percent, of those reporting sell green hides. Each plant reported the average weight, price, date, and to whom their most recent hide sale was made. The bulk of the sales reported occurred in August and September. The average weight of the hides sold green was 42.6 pounds. The average price received was 18.3 cents per pound; however, the prices ranged from a low of 11 cents per pound to a high of 23 cents per pound. The cured hides had an average weight of 40 pounds and sold for an average price of 24.5 cents per pound. The spread between the average prices for green and cured hides was 6.2 cents per pound. The lowest price received for cured hides was 19.75 cents per pound, which was 1.45 cents above the average price for green hides. The gross returns for a 42.6 pound hide after it had cured, assuming an average shrink of 15 percent, would be $1.08 more than the gross returns if sold green. Other factors such as hide pattern and trim might account for part of this difference, but it does indicate that an additional return can be had by curing hides. The principal cost of curing is the salt used, which amounts to about one pound of number 2 rock salt per pound of green hides. The initial fixed cost would include a hide room which should be separate from that portion of the plant where edible products are handled. This room should be ventilated, free from sunlight, and have a concrete floor with a drain. High temperature and low humidity are undesirable because they will cause excessive hide shrinkage. A temperature of 45 to 55° F. and a relative humidity of 75 to 85 percent are desirable. If a cellar is not available, a small amount of refrigeration may be required in the summer to keep the temperature down in the hide room.

It has been estimated that a plant should kill at least five cattle a day to consider the curing of hides.[38] The average weekly winter volume of slaughter for 32 locker slaughter plants was 14 cattle. Under some conditions it might be desirable for plants of this size to cure their hides; however, the larger plants should find it profitable to provide a hide room for curing.

The locker plants that are now curing hides have a weekly winter volume of slaughter of 20 or more head of cattle, with the exception of two plants which slaughter 7 cattle or less per week.

Hog hides should be mentioned since such a large percent of the locker slaughter plants skin all or part of the hogs slaughtered. There are two markets for these hides; one is the rendering firms and the other is the hide buyer. The prices currently being paid vary from 50 cents to one dollar each, the average price being close to 75 cents each.

In summary, every slaughter operator should keep posted on hide prices. In addition, every plant should strive to improve hide quality through better take-off and trim. Finally, if any plant slaughters five or more head of cattle per day, the hides should be put down to cure.

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[38] Dillon, C. E., Meat Slaughtering and Processing, (Meat Merchandising Inc., St. Louis, Missouri, c. 1947), p. 38.

Inedible Viscera, Blood and Bones

Many of the small slaughter plants which do not have sufficient volume of slaughter to warrant the installation of inedible rendering equipment depend on the pick-up service offered by large desiccating companies for disposal of inedible viscera, blood, and bones. Another means of disposal is to sell or give this raw material to farmers for hog feed. This practice is undesirable from a sanitary standpoint, and the feeder is subject to a license fee of $275 per year. However, this regulation is not strictly enforced at present.

The licensed desiccating plants were surveyed through a mailed questionnaire to obtain information on the number of small slaughter plants served by their trucks, the prices paid for viscera and bones, and the frequency of the pick-up from these small plants. Seven operators returned the questionnaires, representing almost complege coverage of the plants in the western two-thirds of the state. Only three plants in the eastern one-third reported.

A total of 109 slaughter plants were receiving pick-up service from the seven desiccating plants reporting. The largest operator serves 35 slaughter plants and the smallest number reported was five slaughter plants.

Four of the desiccating plant operators reported that the price paid for inedible offal varied with the market price of the end products, the grade of raw materials and the distance hauled.

Two of the plants paid one cent a pound for inedible viscera while another plant paid one-half cent per pound.

The price paid for bones ranged from one and one-half to three and one-half cents per pound.

The frequency of pick-up varied from once a week to daily or the day of slaughtering. This has been a difficulty with pick-up service. Inedible offal is extremely perishable, and according to state law shall be removed from the slaughter house within 24 hours after slaughtering. If the group of plants on each pick-up route could coordinate the days on which slaughtering is done, it would help materially in maintaining clean and sanitary slaughter plants. The value of inedible offal has been approximated through the use of average yields as quoted by the Allbright Nell Equipment Company for dry rendering equipment. Current prices were used for the end products, but since grease prices have fluctuated through such wide ranges, two prices have been used which result in two values being attached to the raw materials. Actually, these values will vary considerably due to the market price fluctuations for the end products, especially grease or tallow. The prices used were the same as used in earlier calculations on returns from rendering.

The gross returns to the renderer per pound of raw uncleaned material are shown in Table 28.

Operating expenses and normal profit margins have not been deducted from the figures quoted in Table 28. The final price paid also will be materially affected by the distance involved and the quantity picked up on the truck's run.

Table 28. Gross value per pound of raw inedible offal picked up by large rendering firms.

Name of raw product	Gross value per pound 1/ Grease at 10 cents per pound	Grease at 20 cents per pound
	Cents	Cents
Bones	2.70	4.05
Fat cattle inedible viscera	1.67	2.50
Hog inedible viscera	1.33	2.75

1/ Meat scraps price at $130 per ton
Bone meal price at $60 per ton
Average yields used:
Hog viscera ...... 18 pounds
Cattle viscera ... 180 pounds
Dry rendering yields taken from Tables 25 and 26.

Inedible Tallow and Grease

It has been pointed out that inedible grease and tallow make up a large part of the returns realized from the processing of inedible offal. The division between edible and inedible fats is not clear cut; however, a high percentage of free fatty acids characterizes inedible fats.

Originally tallow came from cattle, calves, and sheep, while grease came from hogs. Present-day usage is not clear cut due to mixing of rendering materials. In general, tallow is hard at ordinary temperature while grease is soft.[39]

Before discussing the market outlets and value of inedible

[39] Zapoleon, L. B. op cit. p. 48.

tallow and grease, the important quality determining characteristics and the commercial uses will be considered. Government specifications for the various grades of tallow and grease were set up and became effective January 30, 1943.[40] These grades are based on four measurements. These are color, acid content, impurities, and titer.[41]

The color depends upon the nature of the materials rendered, their cleanliness and freedom from blood, manure, and contamination, and in the case of dry rendering, upon the care with which cooking has been controlled.

Animal fats are combinations of fatty acids and glycerine. During decomposition the glycerine is lost, leaving the free fatty acid. Fats deteriorate very rapidly in warm places. The free fatty acid content is an important measure of quality.

Another grading factor is the impurities in the grease or tallow. This material comes from the incomplete settling of the wet rendering tanks, dirty raw materials, and the rapid release of pressure in the tank causing the contents to roll.

The titer of a tallow is the solidifying temperature of its fatty acids. Beef fats, in general, have a higher titer than hog fats.

The color and free fatty acid content are the most important

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[40] Davidson Commission Company, "High and Low Records of Fats, Oils and By Products", 1936-1946, p. 11.

[41] _Readings on By Products of the Meat Packing Industry_, _op cit._ p. 111.

grading factors. Light-colored soap must be made from light-colored tallow. A high acid tallow makes a dark soap with an objectionable odor. Therefore, the lower grades of grease and tallow often meet with buyer resistance, especially when supplies of fats and oils are plentiful. In periods of short supply, the lower grades will be accepted by the buyers at relatively high prices.

The principla product made from inedible tallow and grease is soap. Other uses are relatively unimportant in the total consumption of these materials. It follows naturally that the large soap companies are the principal purchasers of inedible grease and tallow.

Small rendering plants can usually dispose of their tallow and grease by selling to hide buyers and other country dealers. These sales are usually made by the barrel and the purchaser takes ownership at the seller's plant. Most of the dry rendering plants sell through brokers in terminal markets or contact soap companies directly for bids. These sales are made on the carload basis.

The possibilities of selling small lots of barreled grease and tallow directly to a large soap company was investigated.[42] It was found that this company would not allow consignments from any plant until they knew what type grease the plant was producing. With the present demand for better quality and color

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[42]Correspondence with J. W. Irwin, Purchasing Agent, Colgate-Palmolive-Peet Company, Kansas City, Kansas, June 24, 1947.

soaps, the darker grades of grease are being eliminated from purchases.

Providing the grade of grease produced was acceptable, delivery could be made directly to the soap company. The barrels are not exchangeable and would be returned at the shipper's expense after the grease was steamed out. Most of the grease purchased from small rendering plants graded between B White and Yellow grease. The corresponding tallow grades are Special and No. 1 tallow.

Two prices have been used in this paper for calculating inedible rendering returns. It was pointed out that grease prices have fluctuated through wide limits since price controls were removed in late 1946. The returns from inedible by-products are affected directly by these erratic price movements of grease and tallow. Some of the basic price determining factors will be mentioned here along with the long-time average prices for these products.

The prices of fats and oils tend to move as a group and are rather sensitive to changing market conditions. Lard is commonly termed the barometer of the fats and oils.[43] The current price of tallow and grease will in general tend to follow the price fluctuations in the over-all market for fats and oils. Factors which affect the supply side of the market for tallow and grease are the number and average live weight of livestock slaughtered, price differential between edible ane inedible fats, and the

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[43]Zapoleon, L. B., op cit. p. 95.

amount of profit to be had from rendering operations.

Since price controls were removed in October 1946, fats and oils prices have advanced sharply. "For the 12 months beginning October 1946; they averaged 253 percent of 1935-39 prices."[44] This price level may be attributed to the high level of domestic demand and the world-wide shortage of fats and oils. European import demand is especially strong since production there is 35 percent below prewar.[45] Export allocations of fats and oils are still controlled by the government. The variations in quantities exported in each quarter have a marked influence on fluctuations in tallow and grease prices.

The long-time price average should be of some use in expressing the value of grease and tallow. The annual average wholesale prices at Chicago were tabulated for A White grease and No. 1 Tallow for the period 1910 through 1945. The 36-year average price for A White grease was 7.73 cents per pound, and 7.48 cents per pound for No. 1 Tallow. For the period 1920 to 1945 the average prices were slightly less, A White grease being 6.99 cents per pound and No. 1 Tallow 6.67 cents.

The lowest average annual price on record was 2.6 cents per pound for A White grease which occurred in 1932. The highest average annual price prior to 1946 was 17.3 cents per pound in 1918. During 1947, prices for inedible grease and tallow have

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[44] Fats & Oils Situation, January-February, 1946, p. 24.
[45] Ibid.

fluctuated from 10 to 25 cents per pound.

Table 29. Average wholesale prices of A White grease and No. 1 tallow at Chicago, 1910-1945.[1]

Period	Cents per pound	
	A White grease	No. 1 tallow
1910-1945	7.73	7.48
1920-1945	6.99	6.67
1910-1919	9.65	9.56
1920-1929	8.43	8.01
1930-1939	5.03	4.87
1943-1945[2]	8.8	8.4

1/ Original data from Fats & Oils Situation, January-February, 1946, p. 24.

2/ O.P.A. ceiling prices.

"The longer-term trend in prices of fats, oils, and oilseed probably will be downward, as export supplies from world surplus-producing areas are likely to increase during the next few years."[46]

Animal By-Product Feeds

The residues remaining after grease has been extracted from inedible offal by either the wet or dry rendering process are usually converted into animal feeds. In the early stages of by-product development these residues were sold as fertilizer.

[46] Fats & Oils Situation, October 1947, p. 1.

Later, as the importance of protein and mineral supplements in livestock and poultry rations was realized, it became more profitable to convert these rendering residues into animal feed. At present a large part of the packing house residues go into animal feeds.

The definitions of some of the more common animal by-product feeds are reproduced below.[47]

> Digester tankage, meat meal tankage, or feeding tankage is the residue from animal tissues exclusive of hoof, horn, manure and stomach contents, except in such traces as might occur unavoidably in good factory practice, especially prepared for feeding purposes by tanking under live steam or by dry rendering or by a mixture of the products made suitable by drying and grinding. It must not contain more than 4.4 percent of phosphorus (P). If it bears a name descriptive of its kind, composition or origin, the material must correspond thereto.

Digester tankage with bone, meat and bone digester tankage, meat and bone meal tankage, and feeding tankage with bone conform to the same definition as above except there is no specified limit to the precent of phosphorus (P) allowed in the feed. The excess phosphorus would be due to a larger proportion of bone in the feed.

> Meat meal is the ground, dry rendered residue from animal tissues exclusive of hoofs, horn, blood, manure and stomach contents, except in such traces as might occur in good factory practice. It must contain not less than 65 percent of protein and not more than three percent of phosphorus (P). If it bears a name descriptive of its kind, composition, or origin it must correspond thereto.

Meat scraps conforms to the same definition as meat meal ex-

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[47] Commercial Feeding Stuffs, Report of the Kansas State Board of Agriculture, 64(268): 24, 1945.

cept when this product contains more than 4.4 percent of phosphorus (P), it shall be designated "_____" percent protein meat and bone scraps.

> Steamed bone meal is the dried ground product suitable for animal feeding, obtained by cooking bones with steam under pressure.
>
> Raw bone meal is the dried ground product suitable for animal feeding, obtained by cooking in water at atmospheric pressure, undecomposed bone, just enough to remove excess fat and meat. It must not contain less than 23 percent of protein.

The small slaughter plant equipped with wet rendering equipment can produce wet tankage or, when equipped with a dryer, it would be possible to produce a low protein digester tankage. If bones are cooked with the viscera, digester tankage with bone will result. It is also possible to render the bones separately. The residue in this case would be steamed bone meal. The larger slaughter plants with dry rendering equipment generally produce meat scraps, meat scraps with bone, or meat meal.

It was pointed out previously that state regulations prohibit the retail sale of animal feeds unless they are registered by the Control Division. However, this does not apply to wet tankage.

Wet tankage is an extremely perishable product. In the summer wet tankage will sour within 24 hours. During the winter months it will keep for several days. Due to this characteristic it is necessary for wet tankage to be fed to hogs within a relatively short time after it is removed from the rendering tank, if any value is to be realized from it. Apparently the soured tankage does not harm the hogs, but the odor resulting from the fermentation is undesirable, especially if the hog pens are near any houses. Furthermore it is desirable to have this wet tankage removed from the rendering room promptly after each day's rendering. About the only buyers for wet tankage are the hog feeders in the local community. Due to the irregularity of rendering operations it is sometimes difficult to maintain a market outlet for this perishable product. Therefore, several of the operators of wet rendering equipment have found it necessary to have their own hogs to provide a constant outlet for the wet tankage produced.

The low protein digester tankage produced by wet-rendering plants equipped with dryers can be retailed locally or sold to large rendering firms for reprocessing. The tests made on this type of product showed a fat content ranging from 19 to 29 percent, which is relatively high. Several of the large rendering companies contacted indicated that this type of material could be profitably reprocessed to recover additional grease. One plant indicated that they were large buyers of such material.

Like all other animal feeds, low protein digester tankage must be registered with the Control Division before it can be sold to local customers. Due to the wide variations in composition of the feed produced in these small plants, it is difficult to make a guarantee as to the composition and abide by it.

More attention to the proportions of raw materials going to the tank and to the method of operating the tank should aid in reducing these variations. The larger rendering plants are able to control their product by mixing materials with different nutritive contents to produce the desired product. The small plant is, therefore, at a disadvantage in controlling the feed composition since the volume of output is small and the facilities for chemical control of their product are usually not available.

Providing a small plant does sell their low protein digester tankage to local customers, it will be necessary to set the guaranteed percentages of feed constituents at a point equal to the lowest quality feed that might be produced. This will result in a loss on the higher quality feed produced but should keep the operator in compliance with regulations of the Control Division.

The possibility of selling a tankage with a low protein and high fat content to the feed-mixing companies was investigated and rejected as a possibility. The chief objection to the use of such a feed was that an animal-feed with more than 8 to 10 percent of fat does not mix well due to the balling effect caused by the presence of the excess fat. Another objection was that the feeds with a high fat content would become rancid and in so doing would destroy other feed nutrients.

There appears to be a ready market for the bone residues from rendering plants. The large feed-mixing companies are the principal purchasers. However, where the volume of production is too small to warrant shipping to these larger companies, it should be possible to make local sales. Steamed bone meal is valuable as a mineral supplement. The principal minerals contained are calcium and phosphorus; however, the material is used chiefly as a phosphorus supplement in feeding livestock. When used for this purpose steamed bone meal competes directly with defluorinated rock phosphate.

The larger dry rendering plants can market a finished animal feed through feed dealers, or the unground residue may be sold in carload lots to large feed-mixing companies. Since this study is concerned chiefly with small rendering plants this phase of the marketing problem will not be expanded further.

The value of protein supplements such as tankage and meat scraps is determined primarily by the quantity of digestible protein contained in the feed. The dry rendered product tends to be more valuable per unit of protein contained than wet rendered tankage. "Dry rendered meat scraps, containing 50 to 55 percent protein, has generally been equal or superior in feeding value to digester tankage containing 60 percent protein."[48]

Since the low protein tankages produced in small wet rendering plants usually contain a high percentage of fat and minerals, an investigation was made to determine if any additional returns could be realized from the sale of such feeds over and above the value of the protein contained. The chief use of this type of tankage is for hog feed. Previous discussion has indicated the undesirability of such a material in the manufacture of mixed feeds.

Table 30 shows the average analysis of three protein supplements of the quality produced by large rendering plants and the

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[48]Morrison, F. B., Feeds and Feeding, 20th Edition (Ithaca, New York, 1936) p. 97.

Table 30. Average analysis of protein feeds produced by large rendering plants compared to low protein tankages produced by small wet rendering plants.

Feeds tested	Percent of feed constituents: Crude protein	Crude fat	Crude fiber	N.F.E.	Cal-cium	Phos-phorus
Meat and bone scraps1/	50.0	9.0	2.5	2.0	10.0	5.0
Meat scraps1/	55.0	9.0	2.5	2.0	8.0	4.0
Tankage1/	60.0	9.0	2.5	1.0	6.5	3.0
Low protein tankage2/						
Tankage No. 1	35.0	29.0	9.0	9.5	6.3	1.5
Tankage No. 2	32.0	19.3	2.8	11.9	9.6	4.4
Tankage No. 3	23.0	23.0	2.0	2.0	15.0	7.0

1/ Average analysis of samples by Official Feeds Testing Laboratory, Kansas State College, Manhattan, Kansas.

2/ Analysis of feed samples obtained from three small wet rendering plants in Kansas, 1947.

analysis of three low protein tankages produced by small wet rendering plants. The tankage from the small wet rendering plants contains about one-half as much protein and two to three times as much fat as the meat scraps and tankage from large rendering plants. Tankage No. 3 contains a large proportion of bone which tends to reduce the percentage of protein and increase the percentage of calcium and phosphorus. Tankage No. 1 represents a sample of the feed produced in the analysis of wet rendering on cattle offal. Tankage No. 2 is a sample of the tankage produced in the analysis of wet rendering on hog offal. The high percentage of nitrogen-free-extract (N.F.E.) resulted from insufficient cleaning of the viscera going to the tank for tankages 1 and 2.

In tests at the Indiana[49] and Ohio[50] experiment stations, the low protein wet rendered tankages were worth more per unit of protein than high-grade digester tankage or meat scraps. Another test at Iowa station showed unfavorable results from feeding a low protein tankage to hogs.[51] However, investigation reveals that the tankage used in the Iowa test contained a high percentage of minerals. The conclusions reached were, "if one has too much mineral matter present in proportion to the protein needed to balance the corn, the extra mineral matter is useless, creating too much bulk and waste matter, an excess of which inhibits feed consumption, increases the feed requirement, and decreases the gain."[52]

Recognizing that a pound of fat is equal in heat and energy value to 2.25 pounds of carbohydrates and furthermore that a hog can convert fat, carbohydrates, and if necessary, proteins into animal fat, it seems reasonable to attribute the excess value per unit of protein for low protein tankage to the high fat content.

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[49] Purdue University Agricultural Experiment Station, Mimeo. report, October 20, 1929.

[50] Robison, W. L., and Rando Beatty, Ohio Agri. Exp. Sta., Mimeo. report, 1935.

[51] Evvard, John M., and C. C. Culbertson, Iowa Agri. Exp. Sta., Mimeo. report, 1923.

[52] _Ibid._, p. 6.

This assumption is further substantiated by investigations conducted by Robinson,[53] at the Ohio Agricultural Experiment Station in an effort to determine the value of fat in rations for swine.

> Up to the highest level tried, each increase in the percentage of fat in the ration, without exception, increased the rapidity of the gains and the amount of gain per unit of feed consumed .... Usually the price of fats is such that it is not economical to include them in the ration, except as they are present in feeds of which the ration is composed .... Sometimes it may be possible to profit from using a feed that is comparatively high in a firm fat. For example, the fat in tankage is of animal origin and usually firm; hence, a tankage that is relatively high in fat is not likely to have a softening effect on the pork produced.[54]

For the purpose of determining the value of low protein tankage, it is assumed that the average tankage of this type will contain 30 percent protein and 20 percent fat. With 60 percent tankage selling at $140 per ton, the value of each unit of protein would be $2.67 ($140/60). On the basis of protein content, 30 percent tankage would be worth $80.10 per ton (30 x $2.67). The average fat content of 60 percent tankage as shown in Table 30 was 9 percent. Therefore, the 30 percent tankage contains 11 percent more fat than the 60 percent tankage. This excess fat will furnish digestible nutrients which could replace part of the corn in the hog ration. The total digestible nutrients furnished by the excess fat should be equal in value to the amount of corn necessary to furnish an equal amount of digestible nutrients. Number two yellow corn contains 80.6 units

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[53]Robison, W. L., "Fats in Swine Rations," Bimonthly Bulletin, No. 224, Ohio Agri. Exp. Sta., p. 203, 1943.

[54]*Ibid.*, p. 208.

of total digestible nutrients per 100 units of weight.[55] With corn at $2.50 per bushel, which equals $89.20 per ton, each unit of total digestible nutrients in a ton would be worth $1.11 ($89.20/80.6). The 11 percent excess fat in the low protein tankage will produce 24.75 units of total digestible nutrients (11 x 2.25). Since the digestible nutrients in corn were worth $1.11 per unit, the total value of the excess nutrients in the tankage would be $27.47 per ton ($1.11 x 24.75). Adding this to the value of the tankage based on protein content, $80.10, the total value would be $107.57. This value will vary with the price of 60 percent tankage and corn and is presented here merely to illustrate a method whereby a value could be attached to low protein tankage. Actual feeding tests might not verify all the assumptions that were made in arriving at the final value. However, low protein tankage containing a high percent of fat appears to be more valuable than the protein content would indicate. Whether this value could be reflected in the price of this type of tankage depends almost entirely on the selling ability of the producer.

A question that will arise in the marketing of low protein tankage is the quantity that should be fed to growing pigs. An average ration of one pound of 30 percent tankage and three and one-half pounds of corn should be sufficient for a 100-pound pig in a dry lot. This recommendation is based on figures from

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[55] Morrison, F. B., op. cit., p. 980.

Morrison's Feeding Standards. If wet tankage is fed, it will require about three times as much tankage due to the increased moisture content.

A summary of average annual prices for 60 percent digester tankage is shown in Table 31. The average annual wholesale price at Chicago over a period of 26 years, 1920-1945, was $58.43 per ton. The highest average annual price recorded prior to 1946 was $107.10 per ton in 1920. The lowest average annual price occurred in 1932 when a price of $24.30 was reported. The current 1947 level of 60 percent tankage is approximately $130 per ton at the wholesale level, which is considerably above the average prices recorded for the period 1920 to 1945.

Table 31. Average annual wholesale prices of 60 percent digester tankage bagged at Chicago, summarized by periods, 1920-1946.1/

Period of years making up average	Average price
	dollars
1920-1929	67.68
1930-1939	43.80
1940-1945	67.42
1920-1945	58.43

1/ Feed Statistics, U.S. Dept. of Agr., Bur. Agr. Econ., October, 1946.

Dog Food

The preparation and sale of dog food offers a market outlet for by-products of slaughtering and processing that might otherwise be wasted. One locker plant reported that they were selling inedible scraps made up as a dog food for 7 1/2 cents per pound.

Such items as lungs, livers, hearts, kidneys, hog stomachs, and beef melts contain little if any fat and, therefore, are of little value when added to the inedible rendering tank or sold as inedible viscera to the rendering firms. Other items such as bacon rinds, lard cracklings and green bones can also be used in the proparation of dog food.

Care must be taken in the selection and preparation of these materials so as to produce a finished product that will be palatable and nourishing to dogs and at the same time attractive in appearance and odor to the purchaser.

The essential equipment for the preparation of dog food consists of a kettle or cooking vat, a small burner to furnish the heat for cooking, a meat grinder, and cooling pans.

The actual formula for making dog food will vary from plant to plant, depending on the type and amount of raw materials available. In general, a simple mix will include lungs, melts, and bacon rinds. These ingredients will be cooked and run through a grinder, and then mixed with a cereal or binder flour. In order to preserve the product and give it a bright red color, a preservative such as regular ham pickle or curing salt should be added. There are many other refinements in the process that can be followed. Some of these would be to add ground bone or steamed bone meal, charcoal, and cod liver oil in order to make a completely balanced dog ration.[56]

After cooking, the dog food can be canned, put in cartons, or wrapped in heavy paper before offering it for sale. It is suggested that each package be plainly labeled.

Dog food formulas can be obtained by writing to The Griffith Laboratories, Chicago 9, Illinois.

Glands

Certain animal glands are used in the manufacture of pharmaceuticals. At present the meat packing industry is the sole source of supply for raw materials used in manufacturing many medicinal compounds. Insulin provides an excellent example. Insulin is the material taken by diabetic persons which enables them to carry on a nearly normal life. The only important source of insulin is the pancreas taken from cattle, calves, and hogs. Insulin was discovered in 1922, and since that time has been put to wide use in controlling diabetes. It takes twenty pounds of pancreas, which is equal to the amount from 40 beeves, to furnish the insulin for one diabetic for one year.[57]

Several large pharmaceutical companies were contacted to de-

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[56]Dillon, C. E., <u>op</u>. <u>cit</u>., p. 177.

[57]Rice, Dr. R. M., Director Medical Division, Eli Lilly and Company, Printed pamphlet, 1946.

termine the possibilities of marketing glands salvaged by small slaughter plants. In general, these large firms prefer to purchase their needs from the large meat packers who have veterinarian inspection and can deliver large quantities of animal glands. However, there is one notable exception. One large company is making a special effort to interest small slaughter plants, and especially locker slaughter plants, since they are equipped with quick-freezing equipment, in saving the pancreas gland from cattle and hogs.

Table 32 lists the number of animals required to make a pound, the current price per pound, and the value per animal for a number of different glands. Any plant interested in saving these glands should contact some of the large pharmaceutical firms for prices, and current information on the possibilities of developing a market outlet for certain glands. Apparently the only gland that would be practical for locker plants to save at present would be the pancreas.

In a previous section it was stated that the estimated weekly winter volume of slaughter of 32 locker slaughter plants was 12 cattle, 2 calves, and 11 hogs. At current prices, the pancreas glands, if saved from all the cattle, calves, and hogs, would be worth $3.07 per week. It would require four to six weeks to accumulate enough beef glands for a shipment and 14 to 19 weeks for a shipment of hog pancreas. The minimum sized shipment acceptable ranges from 25 to 35 pounds. The maximum length of time these glands can be accumulated without losing their insulin is six months, and the company prefers to keep this storage

Table 32. Returns per animal from the sale of various pharmaceutical glands, 1947.1/

Name of gland	Number of animals to make one pound	Price per pound	Value per animal
		Cents	Cents
Beef pancreas	2	34	17
Calf pancreas	10	59	5.9
Pork pancreas	6	50	8.3
Beef bile	4	14.75	3.7
Beef suprarenal	30	175	5.8
Hog stomach linings	4	8	2
Beef thyroid	20	50	2.5
Hog thyroid	40	100	2.5
Beef ovarian	40	75	1.9
Hog ovarian	40	85	2.1

1/ Price and yield data obtained from Eli Lilly and Company, Indianapolis, Indiana, June 17, 1947.

period down to three months. It is necessary to ship hog and beef glands in separate containers. According to the average yields in Table 32 it would take 50 to 70 head of mature beeves to make up a shipment of pancreas glands. A plant with an average weekly slaughter of only two to three head of cattle could accumulate a shipment of beef pancreas worth $8.50 to $11.90 in a six-month period. If the company insisted on a maximum storage period of three months, the minimum average volume of beef slaughter necessary for the sale of glands would be four to six head of cattle per week. It would take 150 to 210 head of heavy hogs to make up a shipment of pancreas glands. The minimum average weekly volume of slaughter required to accumulate a shipment of 25 to 35 pounds of pancreas glands would be 6 to 9 head if stored for the six-month period and 12 to 18 head per week if accumulated in the three-month period. A shipment of pork pancreas weighing 25 pounds would be worth $12.50 at current prices and a 35-pound shipment would be worth $17.50.

This particular company buying pancreas pays all the shipping expenses from the slaughter plant. Due to the nature of the product, these glands must be kept in a frozen condition until they reach their final destination. All shipments from small slaughter plants in this area are consolidated at a cold storage plant in Kansas City for reshipment to the pharmaceutical firm. The local slaughter plant operator should ship the glands to Kansas City by refrigerated truck or pack the glands in dry ice and ship by express.

The instructions on how to save, process and ship glands can be obtained by writing to Eli Lilly and Company, Indianapolis, Indiana. Some of the general precautions are to remove the pancreas from the viscera, strip it of fat, and chill it as soon as the animal is eviscerated. Glands should not be washed or soaked in water. The glands must be individually quick frozen as soon as possible and kept at a sub-freezing temperature until delivered. Not over one hour should elapse from the time of killing the animal until the pancreas glands are taken to the freezer.

It was surprising to find that some of the larger non-federally inspected slaughter houses were not saving glands since the only equipment required is a quick-freeze cabinet. One of the managers of such a plant indicated that they planned to start saving glands in the near future.

SUMMARY AND CONCLUSIONS

The purpose of this study was to gather and analyze information that will assist the operators of small slaughter plants in making more efficient utilization of inedible by-products.

There are three principal requirements upon which the development of slaughter plant by-products are based. They are as follows: (1) necessity of a practical commercial process of manufacture, (2) market outlets for the proposed products, (3) need of adequate supplies of waste used as raw materials, gathered in one place or capable of being collected at sufficiently low cost.

Small slaughter plants should recover some value from inedible by-products to meet the competition of large packers and other slaughter plants which have markets for this material. Custom slaughter plants usually gain possession of a large portion of the inedible offal at no cost. Any value recovered could be shared with the patron through lower processing charges and improved service. This would also result in a competitive advantage over similar plants which do not utilize these by-products.

There was a total of 358 slaughter plants in Kansas in September, 1947. Forty-one percent of these plants were associated with frozen food lockers. Thirty-one percent of the 485 locker plants in Kansas now have slaughtering facilities. Due to the rapid growth of the locker industry and trend toward a complete locker plant with slaughtering facilities, the number of small slaughter plants in Kansas is increasing.

There are numerous laws and regulations affecting the disposal of inedible by-products. The State Board of Health endeavors to protect human health through the enforcement of regulations pertaining to the plant's physical facilities and methods of handling food products. All slaughter plants are required to obtain a license annually. The Livestock Sanitary Commission protects livestock from disease by supervising a number of activities in the livestock industry. The Rendering Plant Act is enforced by this agency. The Control Division of the State Board of Agriculture has among its duties the enforcement of regulations pertaining to the sale of animal by-product feeds. A survey of city ordinances revealed that the large cities have more complete and detailed regulations in force affecting slaughtering and rendering. Three types of ordinances were most common. They were specific slaughter ordinances, zoning ordinances and general nuisance ordinances.

A primary problem of governmental agencies is sewage disposal and stream pollution. Stricter control can be expected in the future. Other regulations affecting inedible utilization pertain to fire insurance and minimum wage regulations.

A survey of locker slaughter plants emphasized the need for more efficient utilization of inedible materials. Sixty-five percent of the plants contacted receive no returns from inedible viscera. The principal methods of disposal were through pick-up service by larger rendering plants and feeding raw viscera to hogs. Only six percent of the plants did inedible rendering. The unavailability of equipment has been an important factor in retarding the development of inedible by-product utilization.

The wet and dry rendering processes are the principal commercial methods for processing inedible offal from slaughter plants. The wet process is the older method. The size of wet rendering equipment limits its use to plants having an average weekly slaughter of at least four to eight cattle per week or its equivalent. The cost of wet rendering tanks with boilers varies from $600 to $1000 at the factory. Tankage dryers are the most expensive unit since they cost from $1400 to $2000. Dryers are not used extensively in small plants due to their high initial cost and high cost of operation.

The most desirable location for wet rendering equipment is in a small building near the slaughter plant. The odor produced is undesirable and difficult to eliminate and must be kept out of the slaughtering and processing part of the plant. This characteristic of rendering may prevent slaughter plants located in cities from installing inedible rendering equipment. Odors can be partially controlled by cooking offal while fresh and condensing the odors from cooking in a water-type condenser.

An analysis of wet rendering indicated that an average yield of inedible tallow from a mature cow or steer varies between 12 and 18 pounds and the grease yield from butcher hogs was approximately two pounds after gut fats have been removed for edible rendering. The tankage produced has a high fat and low protein content which indicates the inefficiency of the wet rendering process as used in small plants.

Dry rendering is limited to much larger slaughter plants due to the size and high cost of equipment. Only a few of the larger wholesale slaughterers have sufficient volume to warrant the installation of this equipment. The minimum cost of equipment would be approximately 8 to 12 thousand dollars. It is doubtful if a plant could efficiently operate present sized equipment with a slaughter volume of less than 10 head of cattle or its equivalent per day and should have a weekly volume of 50 to 100 cattle. Dry rendering is much more efficient than wet rendering and could benefit small operators if a cooperative rendering plant were organized or if smaller equipment could be successfully designed.

The principal market outlet for hides from small slaughter plants is through country dealers. The returns from hides could be increased by more careful attention to hide take-off trim and curing. Plants that kill five or more cattle per day should find it profitable to grade and cure their hides.

The feeding of raw offal to hogs should be discouraged. The most desirable market for raw inedible offal produced in small slaughter plants which do not have sufficient volume to warrant the installation of their own rendering equipment is the large desiccating companies which offer pick-up service. The chief disadvantage of pick-up service is the irregularity of pick-up and the refusal of some large rendering firms to pay for the raw materials. The prices offered for raw offal vary with the current price of grease and tankage, and the distance the material is hauled.

Inedible grease and tallow are used extensively in the manufacture of soap. Small rendering plants can sell barreled grease through country dealers or if proper arrangements are made, it can be sold directly to large soap companies. It is important that care be taken in cleaning and rendering inedible offal so as to produce a high quality fat, especially in periods of declining prices when buyers are more selective.

The wet tankage produced in small wet rendering plants is not readily salable except possibly to local hog feeders due to its undesirable physical properties. This wet material is valuable as a hog feed. Some operators keep their own hogs to utilize this tankage. When dried, this type of tankage is low in protein and high in fat and may be sold as a protein feed or to large rendering plants for reprocessing. Due to the high fat content this tankage is more valuable than the protein content alone would indicate. It is difficult for small wet rendering plants to produce and sell a dry finished tankage in strict compliance with state regulations due to the difficulty of controlling chemical contents of the feed. There is a ready market for bone meal and dry rendered meat scraps.

The sale of inedible scraps in the form of a prepared dog food is considered to be a profitable practice.

The principal gland that could be profitably saved in small plants is the pancreas from cattle and hogs. Plants with a weekly slaughter of 4 to 6 head of cattle and 12 to 18 head of hogs should consider this opportunity. There are many other valuable glands but the large packers usually dominate the market.

The operators of small slaughter plants should attempt to utilize inedible offal. This will require an understanding of the regulations affecting inedible disposal. The sale of inedible offal to large rendering firms should be encouraged, but if the service is poor, and insufficient returns are realized, a cooperative dry rendering plant should be considered as a possible long time market for inedible offal. Wet rendering would be profitable for many small plants, but there are many limitations to its use which should be considered before installation. Dry rendering equipment is too large and expensive for the most of the small slaughter plants. All slaughter plant operators should keep themselves informed as to the current market prices for inedible products. This will enable them to bargain more effectively with purchasers of by-products.

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APPENDIX

Fuel consumption by small vertical tube boilers used in small slaughter plants.

1. Operating data

   Boiler efficiency = 60%1/

   One boiler horsepower = 33,472 Btu per hour2/

   Operating pressure of boiler = 50 pounds

   Heating value of natural gas = 1000 Btu per cu. ft.3/

2. Calculated fuel consumption for 3½ H.P. boiler burning natural gas.

   Output = 3.5 H.P. (33,472 Btu per hour) = 117,152 Btu per hour.

   $$\text{Input} = 100\ \frac{117{,}152\ \text{Btu}}{60} = 195{,}250\ \text{Btu per hour.}$$

   Gas consumption per hour =

   $$\frac{195{,}250\ \text{Btu per hour}}{1000\ \text{Btu per cu.ft.}} = 195\ \text{cu. ft.}$$

   Gas consumption per 8 hour run =
   195 cu. ft. x 8 = 1560 cu. ft.

3. Calculated fuel consumption for 5 H.P. boiler burning natural gas.

   Gas consumption per hour = 279 cu. ft.

   Gas consumption per 8 hour run = 2,232 cu. ft.

4. Calculated fuel consumption for 12 H.P. boiler burning natural gas.

   Gas consumption per hour = 669 cu. ft.

   Gas consumption per 8 hour run = 5,352 cu. ft.

1/ Marks, L. S., Mechanical Engineers Handbook, (New York, New York c. 1941) p. 1167.

2/ Ibid., p. 1162.

3/ Ibid., p. 820.

Electricity consumption by electric motors used on rendering equipment.

1. Operating data for 10 to 25 H.P., 3 phase, 220 volt electric motors.

   Motor efficiency 85%1/

   One horsepower .746 KW2/

2. Calculated consumption of electricity by 10 H.P. motor.

   Output = 10 H.P. x .746 = 7.46 kw. hr.

   Input = 100 $\frac{7.46 \text{ kw.}}{85}$ = 8.78 kw. hr.

   Electricity consumption per hour = 8.78 kw. hr.

   Electricity consumption for 10 hour run = 87.8 kw. hr.

3. Calculated consumption of electricity by 15 H.P. motor.

   Electricity consumption per hour = 13.16 kw. hr.

   Electricity consumption per 10 hour run = 131.61 kw.hr.

1/ Marks, L. S., Mechanical Engineers Handbook, (New York, New York, c. 1941) p. 2020.

2/ Ibid., p. 73.