

**INEDIBLE ANIMAL FATS
IN THE UNITED STATES**

I. B. ZAPOLEON

FATS AND OILS STUDIES

No. 3 DECEMBER, 1929

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**INEDIBLE ANIMAL FATS IN THE
UNITED STATES**

FATS AND OILS STUDIES
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**Considered with Special Reference to Sources of
Animal Waste, the Rendering Industry, Municipal
Reduction, and Some Effects of Meat Inspection**

By

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**FOOD RESEARCH INSTITUTE
STANFORD UNIVERSITY, CALIFORNIA**

THE FOOD RESEARCH INSTITUTE

was established at Stanford University, California, in 1921, jointly by the Carnegie Corporation of New York and the Trustees of the Leland Stanford Junior University, for research in the production, distribution, and consumption of food.

DIRECTORS

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PREFACE

Local industry—local in the sense of freedom from the pressure of broad national or international developments—can no longer be said to exist. Controllable internal factors, such as plant efficiency, remain of prime importance; but industrial management finds it increasingly necessary to take into account a complex group of external or environmental conditions—changes in related or competing industries, in materials and trends of demand, tariffs or public regulation, and so forth—that are largely beyond control. In respect to these latter factors the problems of management are those of foresight and rapid adjustment. Furthermore, the relation between government and business is becoming ever closer. Business is affected by innumerable acts of government; and it constantly seeks or opposes some form of governmental action.

Successful adjustment to these external factors requires, on the part of business management, the grasp of a mass of information respecting inter-industry relationships, fundamental trends, social interests, and public regulation that is not readily available to the average management immersed in the immediate problems of production and marketing. At the same time, informed legislation and efficient public administration must usually rest upon an understanding of economic and technological facts that are not readily available to public officials. It is the purpose of this volume to make some contribution toward the co-ordination and interpretation of such a body of facts, bearing upon problems of business and public policy, in relation to a group of animal by-product industries which present such problems to a significantly high degree.

The complexity of these industries, the large measure of local variation, and the scarcity of published information, all unite to make the task a difficult one. Especially in regard to the salvaging industries—the rendering plants, municipal reduction works, and the hog farms feeding municipal wastes—the recorded information is extremely scanty; mainly it is, in the form of fugitive notes in trade periodicals, and incidental notes on the technique of production appearing in books upon the slaughtering, meat-packing, and fats and oils industries. In the course of years, furthermore, federal and local regulations have become so integral a part of the present status of the meat and by-product industries that the influence of these regulations is not easy to discern, nor the relation of such regulation to the radically different conditions existing today. Of necessity, therefore, the method of approach has been in considerable part one of direct observation, extensively supplemented by interviews and correspondence with informed persons. The study is subject to the errors of such an approach.

Without the good offices of the trades here considered, and of allied interests, the present investigation would scarcely have been feasible. For a critical reading of the manuscript before its final revision, and for much information not readily available in published form upon packing-house practice and by-products, we are indebted to the Institute of Meat Packers. For similar co-operation, and for many other courtesies, we are indebted to Dr. R. A. Clemen, Assistant Director of Armour's Livestock Bureau, to Mr. Paul I. Aldrich, Editor of *The National Provisioner*, and to Mr. W. B. Allbright of the Allbright-Nell Company. Acknowledgment is made of generous assistance rendered by Dr. R. P. Steddom, Chief of the Meat Inspection Division of the Bureau of Animal Industry in the United States Department of Agriculture, and by Dr. John R. Mohler, Chief of the same Bureau, who

supplied and explained many details regarding federal meat inspection. Mr. LeVerne Beales, Chief Statistician for Manufactures, Bureau of the Census, supplemented many details of the published census data. Partly through visits to factories or offices, and mainly through correspondence, much information was obtained from interstate and local slaughterers, and from renderers, municipal reduction plants, manufacturers of rendering equipment, soap makers and other processors of fats and oils, city health officials, federal, state, and city meat inspectors, and others. To all of these, too numerous to mention individually, thanks are due for a considerable measure of local or general information.

It should be emphasized that the information obtained from all these sources pertained to matters of industrial fact or details of regulation. To none of those consulted does any responsibility attach, directly or indirectly, for the organization of such facts, for the channels which this investigation has taken, or for the interpretations, conclusions, and remedial suggestions. Since this study deals in part with questions of trade policy, regulation, and the like, which may well be of a controversial nature, it is fair to emphasize this point.

Within the Food Research Institute the author received substantial aid from his associates. Particular acknowledgment is made of the criticism and aid of Dr. C. L. Alsberg. For a critical reading of two drafts of the manuscript the author is indebted to Dr. J. S. Davis. He has also profited from the valuable suggestions and criticisms of Dr. A. E. Taylor.

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INEDIBLE ANIMAL FATS IN THE UNITED STATES

INTRODUCTION

The present study embodies the results of an inquiry into several obscure industries which are concerned with the salvage of animal by-products and meat wastes. Apart from cognate problems of public health and municipal sanitation, these industries bear an important relation to the food situation. Indeed, only with some knowledge of them can many phases of the production, marketing, and consumption of food be understood. Their growth, representing as it does an increasing utilization of food wastes, reflects certain significant changes in economic conditions.

A notable characteristic of American livestock production, slaughter, and meat consumption is the magnitude of waste or loss, and of inedible by-product. True, the larger meat-packing establishments afford a familiar illustration of efficient utilization of raw materials. Elsewhere, from farm or range to the ultimate consumer, the proportion of waste and economic loss is high.¹ Among the causes of preventable loss are the animal diseases, the toll of which is heavy; the customs and methods of marketing and utilization; the separate regulation of the meat industries by federal, state, and city governments; and the politico-economic conditions attending the disposition of city refuse. All in all, it seems probable that the varied wastes of animal products may reach, in terms of weight,

¹ "Waste" here is used in the sense of complete loss from human use, whether for food or industrial products; and "economic loss" is used to cover the relegation of materials to lower-priced products or uses, by influences not associated with demand or price.

half as much as the amount actually consumed; and the economic losses involved, though relatively smaller, are still very large. To appreciate the importance of these wastes and losses, one has only to recall that animal husbandry is a major branch of American agriculture; that the conversion of meat animals into food and industrial products ranks, in value of product, as the leading manufacturing industry;¹ and that of the average dietary, foods of animal origin (including dairy products) provide approximately 40 per cent of the energy at around 60 per cent of the total cost.

It suffices here to observe that different forms of waste and animal by-product offer varying opportunities for salvage; and that a number of closely related trades process such materials for industrial products. Broadly, these trades form six groups: slaughterers and meat packers, renderers, municipal reduction works, and producers of glue and gelatin, fertilizer, and bone black or bone char. To these must be added hog farms which utilize much animal waste but produce, of course, edible products. The main industrial product is inedible animal fat—greases and inedible tallow; the residual meat and bone meal, known as tankage or cracklings, is extensively employed in concentrated feeds and in fertilizer mixtures. Other products are hides, bones, bone meal, bone char, horse oil, neatsfoot oil, glue, and casings. The uses of these products are almost coextensive with industry.

The potential supply of raw material is immense. It is a heterogeneous class of material that cannot or may not be used for food or food fats, either because of some form of contamination or spoilage, or because of a complex of regulatory and economic factors. Such are certain classes of packing-house by-products, of which an edible portion

¹ It is second to the motor-vehicle industry, if retail and custom slaughter be omitted. The census embraces only the *wholesale* slaughtering and meat-packing industry.

is forced to industrial use; the carcasses of meat animals rejected in whole or in part for food use owing to disease or for other reasons; spoiled meats; the trimmings and meat wastes of innumerable meat markets; dead farm and city animals; the by-product of poultry-packing plants; and the kitchen waste of households and restaurants gathered either by the municipalities or by scavengers.

Manifestly, the bulk of this material is an incident of meat production and consumption. Yet the demand for the industrial derivatives is growing much more rapidly than is the production of or demand for the primary product, meat. To this fact, in part, is to be attributed the recent growth of the salvaging trades. Imports are also large, and apparently increasing in volume. Although only a limited portion of the domestic supply of material is being reclaimed, the processes of salvage now yield a large product of industrial raw materials. In diverse and interesting ways the business registers the influence of contemporaneous changes in the food habits of the population, as well as changes in economic and physical conditions.

This study, then, deals with the industries that produce industrial raw materials either from by-products of slaughter or from wastes. Chief attention is given to inedible fat. It is the main product, in the aggregate; it is produced as a major or incidental product in all of the six groups; and in no other way can one gain so effective an approach to the causes and sources of waste, and to the problems and trends of recovery.

The supply of fat-yielding materials, it has been observed, is conditioned by the proportion and commercial availability of waste, as well as by the production of meats. But in other important directions the inedible fats exert a positive influence upon the food-fat situation. The United States has a large but diminishing surplus of the

relatively high-priced edible fats, collectively considered; but it imports (including the oil equivalent of foreign oleaginous materials) about 1.6 billion pounds of vegetable oils, the great bulk of which goes to non-food uses.¹ It is in this wide field of industrial use that economic and technical changes have been most pronounced, consumption has most rapidly expanded, and a relative domestic deficiency has developed. The magnitude of the demand by industry is great and steadily increasing. Of the fats and oils of domestic origin which are available for such use, the inedible animal fats now constitute the major portion. Their annual output is exceeded only by that of the three edible products, butter, lard, and cottonseed oil.

Accordingly, to industrial consumers of fats and oils the animal by-product trades offer a large quantity of raw material. To the industries producing fats and oils they offer a twofold competition: the competition of the salvaged fat itself and that of the larger volume of tankage and cracklings which serve many of the same uses as oil cake. Of considerable moment is another and different aspect of the situation. Between the animal greases and inedible tallow, on the one hand, and, on the other, those food fats which dominate the domestic fats and oils markets—lard, the oleos, and edible tallow—no sharp distinction may be drawn. The better grades of white grease frequently cannot be distinguished from lard, and the best grades of inedible tallow are very like the edible product. Though part of the raw material for the inedible product is of repellent character, the commercial fat is sterilized in the course of extraction, and it could readily be refined for food use if this were permitted. Another part is actually of an edible grade, but is substantially

¹Total imports (animal and vegetable, including oil equivalent of seeds and nuts) were 898,088 short tons in 1928; exports were 541,687 short tons. (U.S. Dept. of Agriculture, *Foreign Crops and Markets*, May 27, 1929, pp. 766-67.)

shut off from food use by the regulatory system. And a substantial quantity, but small percentage of the raw and rendered fats classed as inedible, actually does go to food, chiefly to foreign markets. In short, the difference between food fats and industrial fats, in practice, is partly one of gradations in quality and partly the result of government restrictions. A change in such regulations might materially alter the entire situation.

For such reasons a study of the industrial fats seems essential to a clear view of the food-fat situation. Accordingly, the present investigation is presented as one of the earliest of this series of *FATS AND OILS STUDIES*.

Because of its interrelations, the inquiry has led somewhat afield. In connection with the raw materials, it has been necessary to consider certain obscure but important aspects of the production, distribution, and consumption of meats. Examination of the commercial processes of production or extraction requires a study of the rendering and related industries, of collateral aspects of slaughtering and meat packing, and of the municipal disposal of city refuse in reduction works and on hog farms. It is not possible to ignore the economic and sanitary effects of the separate administration of meat inspection by federal, state, and city officials. Such regulation tends to be static, increasingly maladjusted to rapidly changing industries. Finally, some consideration is given to questions of public welfare, as well as of public and business policy, that arise in connection with these matters.

CHAPTER I

MEAT INSPECTION IN THE UNITED STATES

Inedible animal fats are produced mainly by a group of salvaging industries that are either part of or closely related to the meat-producing industry. Federal, state, and municipal regulation so profoundly affects the organization of meat and salvaging industries that some consideration of this regulation is desirable at the outset of this study. The federal "Meat Inspection Act" in particular calls for discussion in so far as it affects production and marketing. Not only has it been the model for numerous state laws and local ordinances but directly or indirectly it affects livestock producers, meat packers, and the various trades concerned with the processing of animal products. The official title of this statute is, indeed, somewhat misleading. It does not limit itself merely to the inspection of meats. The act provides for the inclusive supervision and detailed regulation of the major portion of one of the nation's greatest industries, and establishes one of the most extensive and important of the numerous regulatory services of the federal government.¹

¹The law, as a part of "An Act making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, nineteen hundred and seven," was approved June 30, 1906 (34 Stat. 674). Supplementary legislation was passed in the corresponding appropriation act for the fiscal year ending June 30, 1908, approved March 4, 1907 (34 Stat. 1260). It was further supplemented by the Imported Meat Act contained in "An Act to reduce tariff duties and to provide revenue for the Government, and for other purposes," approved October 3, 1913 (38 Stat. 114, 152, 159); and by the Horse Meat Act contained in "An Act making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1920," approved July 24, 1919 (41 Stat. 241). The text of these acts, together with the regulations for their enforcement, may be found most conveniently in the publication entitled *Regulations Governing the Meat Inspection of the United States Department of Agriculture*

Federal, state, and local regulation alike are primarily concerned with the wholesomeness of meat foods and with insuring sanitary conditions of production. Nevertheless, such regulation serves an important incidental use in lessening the danger of destructive livestock epidemics. Indeed, many animal diseases are far more readily transmitted to livestock than to man; and the contagion may be carried by infected hides and other animal products, feeds, and so forth, as well as by livestock and unsterilized meats.¹

To insure the wholesomeness of meat foods presents distinctive and difficult problems. It was not sufficient to make the shipment of adulterated or misbranded articles punishable as was provided for foods in general by the Food and Drugs Act, enacted by Congress at the same time as the Meat Inspection Act. Ordinarily adulteration or misbranding of foods may be recognized after the finished product leaves the factory. For meat products, however, this is insufficient protection because of the possibility of the transmission of disease from animals to man. The presence or absence of organisms infectious to man cannot routinely be established by examination of

(U.S. Dept. of Agriculture, Bureau of Animal Industry, Order 211—Revised), December 2, 1922. We are not here concerned with the Packers' and Stockyards Act and the Consent Decree, which have mainly to do with the maintenance of free competition and the regulation of business practice.

¹ Widespread epidemics among livestock may result from contact with meat products derived from diseased animals. Thus the very serious outbreaks of foot-and-mouth disease in California in 1924 and 1928 were traced to the feeding of hogs with garbage from vessels that had just returned from the Orient and from Argentina. The danger of rapid spread of epidemics among domesticated animals in the United States is especially great because many animal feeders customarily buy stock for fattening at the great stockyards which receive animals from a wide territory. Thereby epidemics may be widely disseminated. While the Meat Inspection Act was not aimed at the control of livestock diseases, the close supervision of packing houses required by this act immensely enhances the effectiveness of the livestock quarantine and transportation laws, and the regulations thereunder. These deal with the domestic and foreign trade in livestock, hides and skins, wool, and other animal by-products, hay, straw, forage, fertilizers, and bagging materials, as well as the livestock sanitation work calling for immunization, dipping, and disinfection.

the finished meat product. It is impossible in practice to tell after a product has left the packing house whether or not it is a carrier of disease and whether it has come from a sound or from a diseased animal. This can be done only by examination of the animal before slaughter, by examination of the carcass and organs after slaughter, and by general supervision of packing-house construction and operation. A major defect of the earlier meat inspection acts was the failure to provide authority for regulations touching plant construction and sanitation. Adequate water supply and drainage, protection against rats, flies, and other insects and vermin, cleanly handling of products—all these are necessary to guard against the contamination and infection of sound meats. Given these safeguards, made necessary by the characteristics of meat production, meat foods are doubtless as wholesome, or more wholesome, than perishable foodstuffs not similarly supervised.¹

FEDERAL INSPECTION

How to protect the public from unfit or adulterated meat products, how to protect domestic livestock industries from contagious diseases, are in part national, in part international problems. Import quarantines upon livestock and meats have often inflicted hardship upon producers in the United States and other exporting countries. Restrictions of this kind are often regarded, not always without cause, as an effective and domestically palatable substitute for protective tariffs. Such restrictions have been a frequent cause of international friction. Nor has any of the large nations developed altogether satisfactory methods of regulating the various domestic branches of the meat industries.

¹For example, fresh fish are sometimes decomposed or poisonous, and poultry are subject to avian tuberculosis and other diseases which render the meat unwholesome. Such foods are not, of course, subject to the Meat Inspection Act.

In the United States a solution seemed easier because of the concentration of slaughter in large establishments doing an extensive domestic and foreign business. Yet the Constitution confers upon Congress no local police powers. As in many similar cases, the problem was partially solved by invoking that clause of the Constitution which gives to Congress control over interstate and foreign commerce. Upon this provision of the Constitution is based the Meat Inspection Act of 1906, which quieted public agitation and met the demands of the countries importing American livestock and meats. Such legislation was, indeed, essential to the maintenance of the large export trade in these products.¹ This act applies only to plants that ship beyond the confines of a state and to all plants in territories and in the District of Columbia. To the individual states was left the regulation of plants exclusively engaged in the intrastate trade. In the aggregate the business of these is very large.

The federal Meat Inspection Act provides that plants ("any slaughtering, meat-canning, salting, packing, rendering, or similar establishment") shipping the edible products of cattle, hogs, sheep, or goats² in interstate or

¹ Historically, federal inspection and certification of interstate and export shipments was forced by the action of certain large importing countries. Foreign restriction and embargoes, threatening the heavy export trade of the United States, were ostensibly based upon sanitary considerations. Initially, such restrictions were met by inspection and certification of export meats only. When the importing countries deemed this to be insufficient, first ante-mortem and subsequently post-mortem inspection was established.

It is noteworthy that current attempts at inspection of poultry products (the need of which seems to be generally recognized) are the result of a similar situation. Canada has refused admission to poultry meats not accompanied by certificates of federal inspection; and such inspection has been inaugurated at several exporting plants. The reported percentage of condemnations appears to be higher than in meat-packing plants. Poultry inspection is permissive, and not mandatory.

² United States inspection of horses was commenced in September 1919; the number so inspected in each of the years 1926 and 1927 was around 45,000 head. There is an additional uninspected slaughter, of unknown dimensions, for the use of zoölogical gardens, circuses, menageries, and so forth. Horse meat is preferred by such institutions, partly because it is virtually free of tuberculosis. A large part of the inspected horse meat is exported.

foreign commerce shall be open at all times, by day or night, to the inspectors of the Bureau of Animal Industry of the United States Department of Agriculture, the agency intrusted with the enforcement of the law. If meat animals are slaughtered in these establishments, they must be examined ante mortem, before they may be brought into the packing plant proper, and all animals showing symptoms of disease must be segregated and slaughtered separately. The carcass and entrails of animals passed as being sound must also be inspected post mortem to make certain that each animal was free from disease not detectable with certainty during life. "Carcasses and parts thereof" unfit for human food "must be destroyed for food purposes" in the presence of an inspector. Plant construction and sanitation must conform to rules and regulations to be prescribed by the Secretary of Agriculture. The use of unwholesome chemicals, preservatives, or ingredients is forbidden; and further control over labels, brands, and processes is afforded by a clause which states that no false or deceptive labels shall be used. Provision is also made for the inspection and certification of exported meat animals and meats. No clearance may be given any vessel carrying meat animals or meat foods to foreign destinations unless these are accompanied by a certificate of inspection and soundness. Similarly, no public carrier may convey meat foods to interstate or foreign destinations unless these have been marked "inspected and passed" in accordance with the statute. Penalties of various kinds are provided, including withdrawal of inspection and consequent forfeiture of interstate and export trade. Finally, broad powers for enforcement of the act are conferred upon the Secretary of Agriculture, who is instructed to prescribe suitable rules and regulations.

This mandate has necessitated the creation of an extensive administrative machinery, as well as the development of

a comprehensive body of regulations. An adequate force of inspectors—veterinarians and expert lay inspectors—is assigned to each establishment; and the work is supervised and co-ordinated by traveling inspectors and laboratory inspectors. The ante-mortem examination is made in the pens, on the day of slaughter. Animals plainly suffering from such diseases as hog cholera, rabies, tetanus, and milk fever are condemned at once; they may not be admitted to the edible department of the plant. Animals suffering from certain diseases (chiefly anthrax) must be incinerated or completely destroyed. The great bulk of the condemnations for disease, in addition to animals found dead or dying in the pens, are consigned to the tank room, for rendering into inedible fat, tannage, and so forth. "Suspects" must be marked and slaughtered separately. The post-mortem examination of animals "inspected and passed" is made at the time of slaughter; and strict supervision is exercised over the subsequent processes of preparation or manufacture. The carcass of an animal found to be diseased, or under certain conditions merely the diseased part of it, is usually consigned to the inedible department; but under other conditions it may be used for food, if subjected to prescribed treatment. Animals too emaciated or anemic to produce wholesome meat, immature calves and pigs, and a variety of other materials also go to the tank room. Regulations in regard to cleanliness, care of premises, and avoidance of nuisance are also enforced. Other regulations deal with the layout of the plant, drainage, equipment, operating technique, and the labeling and processing of products. In sum, every detail of packing-house practice is closely supervised.

The law provides further that only those "meats and meat food products" may pass into interstate or foreign commerce that have been produced in an inspected establishment; and conversely, that every establishment doing an interstate business in such products must submit to federal regulation. This has been interpreted to mean that if a plant does any interstate or export business whatsoever in meat foods, irrespective of the volume

of such trade, its entire business must be subject to federal supervision and control. It follows that not merely slaughterers, but also any establishment shipping animal foodstuffs or products containing material amounts of ingredients derived from the four principal meat animals, must submit to inspection. Manufacturers of oleomargarine or of lard compounds containing animal fats; packers, provision merchants, and others who do not slaughter but who cure, or process, or manufacture such products as hams, bacon, sausage, and potted meats; canners who merely put up canned meats or products containing meats like chile con carne, soups, and so forth: all these are permitted to use only meat products from federally inspected establishments if they do any interstate business; and they are required to accept federal inspection.

Most of these products, it should be noted, are sold under widely advertised brands and require a broad market. Except, therefore, some who cure hams and bacon and make potted meat, and many who produce sausage, practically all of these are interstate shippers. With the exception of those who do a local business only, they must obtain all of their animal products from federally inspected plants and must submit to federal inspection. For both groups—slaughterers and processors or packers—admission to inspection and compliance with the provisions of the law and the regulations promulgated thereunder are made conditions antecedent to the right to ship in interstate and foreign commerce. The products of such establishments are stamped by the inspecting officials so as to earmark them; or, if they are packaged goods bearing a label (as for example, canned meats), the label must bear the statement that the contents have been inspected and passed. Once the products have left the federally inspected plant they are subject to the provisions of the Food and Drugs Act, so that they may be controlled

should they become spoiled or contaminated subsequent to shipment.

Plants doing a business confined within the limits of a single state are outside the jurisdiction of the federal Meat Inspection Service. Nor can they obtain such supervision so long as they do an exclusively or dominantly intrastate business, even did they desire federal inspection because of its incidental advantages in marketing. Of necessity, moreover, the federal service must take into account the costs of such work and the limitations of its appropriation. It would scarcely be warranted in granting inspection to establishments which make an occasional shipment across the state line, since inspection entails supervision of the entire product of the plant, and the presence of inspectors during the processes of slaughter or manufacture. Supervision of small plants is relatively expensive. Manifestly, complications are likely to arise at cities near the state lines, or at ports where a local producer may desire to supply vessels. This divided responsibility for regulation has important economic and sanitary consequences. For reasons which will shortly appear, these consequences find expression in the production of fats and by-products.

STATE AND CITY INSPECTION

We have, then, in the United States two *different* and *unrelated* kinds of inspection and control: (1) that of the federal Meat Inspection Service, uniform throughout the country, except for inevitable variations in point of view and practice among individual inspectors, but confined to plants that do any interstate or export business; and (2) that of states and municipalities, independently administered and greatly varying in extent and effectiveness. In effect, this second type embraces at least 48 independent administrations, in reality many times 48 administrations, because municipalities are substantially autonomous in

respect to sanitary regulation. Outside of the federal system, meat inspection is today a municipal function. Each city makes independent provision for its own system of regulation, local health officials being commonly charged with enforcement. Even in the few states which attempt an inclusive system, the larger cities usually make independent provision for such work.

The federal inspection stamp is everywhere accepted; generally speaking, also, within a given state different cities reciprocally recognize each other's stamp and accept the state stamp, both subject to reinspection. Differences of opinion develop; one city may disagree with another, or with the state system, for example, in respect to the interpretation of the term "meager and emaciated beef," or the requisite degree of maturity of calves, pigs, kids. Rejections result in friction and attempts at retaliation. The meat supplied by a given slaughterer may be locally accepted and yet be rejected in a large city near by. On the whole, however, such friction has a salutary effect. It tends to "tighten up" local regulation. More serious are other aspects. An interstate plant exercises great care in its purchases of animals, accepting only such as appear to be sound and healthy. "Suspects" are conditionally accepted, at a materially lower price as a rule. This has the effect of reducing losses in the interstate plants; but it also tends to divert animals of doubtful soundness to "unofficial" plants. A farmer or shipper who may wish to dispose of immature calves or pigs, or one who desires to hurry his stock to market before disease reaches an advanced stage, is more apt to take his chances with a non-federally inspected plant. It is asserted that sometimes livestock commission houses, apprehensive of condemnations, likewise prefer to dispose of livestock to such a plant. How important, relatively, such instances are we do not know. That they do frequently occur is common knowledge.

On the whole, the effectiveness of regulation varies greatly in different cities, and outside of the larger cities there is little supervision of slaughter. At the present time, only about five states make statutory provision for state-wide meat inspection; and even there the inspection in smaller communities and rural districts is upon a lower level. In most states, state-wide inspection has never been attempted; in others it has been tried but has broken down under political pressure. There are obvious difficulties in the state or local inspection of small butchers and meat markets, daily slaughtering a few animals and widely dispersed in communities of varying size. Moreover, such inspection is specialized and technical work, necessarily involving a large degree of judgment and entailing some friction. Obviously it is better applied by a large impersonal administrative and scientific organization than by isolated workers appointed by state or local officials, and operating more or less independently. It seems to be the consensus of the trade that few states or cities maintain a supervision comparable to that imposed upon "federally inspected" slaughterers, and that in many places there is virtually no inspection. The legal provision for enforcement is often inadequate; when this is adequate, insufficient funds for enforcement, politics, or incompetence commonly result in lax inspection. Of retail slaughter, and the kill by meat peddlers and farmers, there is as a rule no attempt at inspection.

In June 1925 the federal Department of Agriculture published a study of the retail marketing of meats. This study was based upon a personal canvass (in 1920) of 3,504 retailers in 28 cities in nearly as many states, and of rural districts in 8 counties. According to this study, in some cities operators of slaughterhouses and small stores had never been inspected for sanitation; federal inspection tends to divert animals of doubtful soundness to slaughterhouses without inspection; "many of the local

slaughterhouses operated by individual butchers are not only unsanitary but filthy," the typical small slaughterhouse being so constructed as to preclude the maintenance of sanitary conditions.¹

Yet it is but fair to add that not infrequently the local plants are modern establishments, sanitary and efficiently run. Some are not under federal inspection because a large local market offers an ample outlet for their product. Others limit themselves to an intrastate business in order to avoid the added expense and annoyance of close supervision—the unavoidable "red tape" of a large administrative machine, however efficiently conducted. And very likely the number of plants that knowingly would sell unwholesome meats is not large. Much depends upon the quality of inspection; for while laymen often attain a considerable degree of efficiency in the detection of animal disease, this is essentially work of a technical and specialized character.

Those who slaughter or pack meat products from the four principal meat animals, therefore, fall into two groups: those with federal inspection to whom the channels of interstate and foreign commerce are open, and those subject to the inspection of state or local officials only to whom, with two minor exceptions,² these channels are closed. Hereinafter we shall refer to the first group as interstate, to the second as local (wholesale or retail), establishments. In federal reports the two classes are often termed "official" and "unofficial" establishments, respectively.

¹ H. C. Marshall, *Retail Marketing of Meats* (U.S. Dept. of Agriculture Bulletin 1317), June 1925, pp. 35-36.

² "That the provisions of this act requiring inspection to be made by the Secretary of Agriculture shall not apply to animals slaughtered by any farmer on the farm and sold and transported as interstate or foreign commerce, nor to retail butchers and retail dealers in meat and meat food products, supplying their customers." Authority is given, however, to apply inspection to "establishments" of this kind when so desired by the Secretary of Agriculture. *Interstate* shipments from such sources are relatively small. In the aggregate, however, they supply a large volume of uninspected meat to the local trade.

COMPARATIVE ADVANTAGES OF FEDERAL AND STATE
OR CITY INSPECTION

The federally inspected plant labors under certain handicaps as compared with a local or unofficial plant. In the first place, in the former no animal in questionable health and no carcass or part of a carcass showing evidence of disease may be used for food purposes, although under specified conditions some of this material may be so used after sterilization by heat.¹ In local plants, many of which are only nominally under control by local authorities, it is often largely a question of the operator's conscientiousness and sense of responsibility to the consumer whether or not a given animal or carcass is used for food or "tanked." Indeed, it often requires the experience of a trained veterinarian to decide whether or not a given carcass is fit for food use; and even a conscientious butcher, through ignorance, may assign to food use a carcass that a veterinarian would condemn to the tank. It is to be assumed, then, that taking the situation as a whole local slaughterers suffer a smaller proportion of condemnations than do their interstate competitors. This is a factor of no mean importance. Owing to the narrow margin of profit per animal, even a small percentage of condemnations entails substantial losses.

A second handicap imposed by federal inspection is that, by and large, it necessitates a larger capital investment in plant and equipment, more overhead, and higher operating costs. Adequate facilities and equipment for inspection must be supplied; the layout or construction of the plant must be satisfactory, in respect to concrete floors, drainage, sewage disposal, toilet facilities, separation of departments of the plant producing edible and

¹ Meat bearing a few tapeworm cysts may also be used if held at low temperatures (cold storage) long enough to kill the larvae. Fresh pork trimmings to be used in sausage must either be adequately frozen or processed because of the possible presence of trichinae.

inedible products, and the like. All this is expensive; the capital investment in an official plant is probably about 10 per cent higher than that in a comparable local plant. Only a fairly large and modern plant of the latter class could obtain federal inspection without radical changes in construction. It is asserted, indeed, that the extension of federal or comparable inspection to local plants would compel the rebuilding of most of them. In addition to the higher overhead, federal inspection entails higher operating costs because of more exacting requirements as to sanitation and cleanliness, and restrictions of various kinds, including numerous and doubtless necessary regulations touching the precise handling of different products.¹

A third handicap results from a closer supervision over adulteration and misbranding in a plant in which an inspector is continuously on guard than is possible in one which is only occasionally visited by a local inspector, to say nothing of plants with virtually no local control at all. For example, it is a common practice in local establishments to adulterate lard with tallow, to apply coloring matter or sodium bisulphite to sausage, or to incorporate in sausages excessive amounts of cereal and water, as well as animal tissues of little food value. If local officials are not vigilant, such abuses may go on unchecked, since the authority of the federal government is limited to the control of interstate commerce. In fact, state and municipal officials often make no attempt to check adulteration

¹ Among the prescribed facilities and requisites of federal inspection, to be furnished by the plant, are adequate office space, heat, janitor service, racks, tables, receptacles, trucks, disinfectants; satisfactory pens, equipment, and assistants for ante-mortem inspection; and final inspection places for the inspection of retained carcasses. It may be noted, also, that some handicaps cited by individual operators appear to be minor, and apparently unavoidable, annoyances. For example, an interstate plant must defer changes in construction or buildings until blue prints of proposed changes have been sent to Washington and approved. Likewise, labels on tinned products may not be changed without approval, similarly obtained. The meat-packing industry as a whole, however, strongly favors federal inspection because of its direct and indirect benefits.

or misbranding of this sort. Still more rarely do they attempt to follow the federal example in such details as specifying what hog fats may go into the different grades of lard, what ingredients, coloring matters, labels, and so forth, shall be used.

To offset these handicaps, and certain less important ones besides, interstate plants enjoy a number of advantages. They have the important advantage of an exclusive right to the interstate and export markets for their edible products. They enjoy, besides, notable advantages in the marketing of by-products, shortly to be described. A substantial portion of the local trade prefers the "U.S. Inspected and Passed" products. Constant supervision over sanitation and product tends to maintain quality and to reduce deterioration or spoilage of perishable foods. The service of federal inspection is furnished without charge, its cost being defrayed from the federal appropriation for meat inspection. Unofficial plants usually pay for state or municipal inspection, besides furnishing such facilities therefor as are demanded. An inspection fee is often charged per animal, varying with different animals; or the larger plants pay the salary of the inspector or inspectors continuously employed in this work. Local plants are limited in their market for edible products to the confines of a state. With some unimportant exceptions they may not ship foodstuffs derived from swine, cattle, sheep, or goats outside the state in which the slaughtering is done. For inedible products, however, interstate and local plants are on the same basis; both may ship in interstate and foreign commerce on the same terms.

The federal Meat Inspection Act represents a gradual evolution. It superseded less comprehensive statutes passed in 1890, 1891, and 1895. The act was the culmination of the regulatory experience of a generation, and of a longer period of domestic and foreign controversy. The

essential provisions of the four successive acts were, in fact, the result of the pressure of foreign governments, enforced by embargoes against American livestock and meats. At the time the statute now in force—that of 1906—was enacted, it was thought that it would be adequate to meet the situation because of the concentration of slaughtering in large interstate plants. It was inferred that this tendency would grow and that a relatively larger proportion of the meat supply would come to be prepared in such plants. It was also felt that the states and cities would follow the federal government's example and adopt its system of inspection. These hopes have not been realized. Slaughtering has tended rather toward decentralization than toward centralization; the meat inspection of the states which at first followed the government system has largely broken down; only municipal inspection in certain cities has been kept up to the federal standard.¹

Each year considerable numbers of plants apply for and receive, or withdraw from, federal inspection. Total withdrawals for the five years 1924–28 were 271, and entries 209. It is noteworthy that the number of plants withdrawing from federal inspection has recently been increasing. In the three fiscal years 1926–28 federal inspection was discontinued in 179 plants and inaugurated in 105—a net loss of 74 plants.² In a number of instances

¹In addition to regulations of the kind here outlined, there are a number of local ordinances, varying greatly in different cities and sections. These deal with the segregation in "butchertowns" of slaughterers and renderers, with odors and other nuisances, with the admission of dead animals and offal, with the establishment of municipal abattoirs, and so forth.

²The report of the Secretary of Agriculture to the President for the fiscal year 1927 (*Agriculture Yearbook, 1927*, p. 50) states: "Available funds were insufficient to meet the growing demands for the service. It was necessary to refuse numerous requests for the inauguration of inspection." Of the net excess of withdrawals from federal inspection, a part is thus explained by the shortage of funds—a temporary condition which is reported to have been corrected and not to be likely to recur. Another part of the withdrawals is the result of consolidations or mergers. The remainder is mainly composed of small slaughterers, and of curers or processors who do no slaughtering. Excepting the two years 1926 and 1927, the number of plants under federal inspection did not greatly vary. Upon the relative magnitude of meat production outside of fed-

federal inspection was discontinued for unsanitary conditions and violation of the regulations; but many plants merely "withdrew from interstate trade." Presumably nearly all these 179 plants continued to operate in intrastate or local trade.

Of the broader economic and sanitary problems presented by the existing multiple systems of regulation something will be said in a later section. Here it suffices briefly to outline the effects of the present system of meat inspection upon the production of fats.

EFFECT UPON PRODUCTION OF FATS

The local slaughterer is in a sense the successor of the small butcher of an earlier era. He serves a useful function, especially in the small or remote cities and towns. Farmers and dairymen are provided with a near-by market for meat animals. Such an outlet is especially important for animals that, because of insufficient number or unfinished condition, cannot profitably be shipped to the great markets. The small slaughterer also effects a saving in transportation on livestock to distant markets (and in losses incident to such transportation) as well as in the return freight on meats. The neighborhood is supplied with fresh meats and edible by-products of local origin.

The purchases and output of such a producer are limited by the amount of product that his territory will absorb. His scale of operations is adjusted primarily to the local demand for carcass meats. The demand for the different cuts varies seasonally; and the meats are subject to shrinkage, deterioration, and spoilage. For the large amount of by-product his outlets are comparatively restricted. There is a varying local market for meat specialties such as brains, sweetbread, liver, and tripe. Part of

eral inspection there are no trustworthy data, but there are a number of indications that a growing proportion of the commercial slaughter is not subject to federal inspection.

the surplus meat, as well as of trimmings, cheek meat, and so forth, goes to sausage, the demand for which has greatly increased; part of it is used in mince meat and similar preparations. For hides and skins there is a ready market; frequently, also, there is a local manufacturing demand for bones, blood, and casings. There remains, however, a considerable surplus of by-product. A large volume of raw material and a broad market are both requisite for the production of canned meats, soups, extracts, and the numerous cured or processed specialties which absorb much of the surplus and by-product of the large interstate packers. Therefore the operations of the latter are more flexible and admit of a readier adjustment to prices and market conditions. The unofficial plant may not sell raw materials to the large producers of meat specialties, since these producers are generally under federal inspection. The usual alternative is to render surplus by-product for commercial fat.

Now meats and meat foods are ordinarily much higher priced than commercial fat; and, broadly to state packing-house practice, it is only when such outlets are not available that edible materials are rendered. Nevertheless, a relatively large proportion of the by-product of the local packing plant must be so disposed of. To such a plant the importance of edible fats as an outlet for the residual product would seem to be relatively greater than to the large interstate packer. This market, however, is rather narrowly restricted by the present divided system of regulation.

Only a plant under federal inspection, it will be recalled, may ship edible fats, or other meat foods, beyond the confines of a state. Edible beef and sheep fats—oleo stock and the derived oleo oil and stearin, and edible tallow—are extensively exported, but this market is closed to the local plant. So also, in effect, is the domestic outlet, since such fats are here almost exclusively used for oleo-

margarine and lard substitutes or shortening. With the exception of several small plants doing an exclusively intrastate business in lard compound, only federally inspected fats may be used by such producers. There remains a small outlet in homemade shortening; some suet is also sold to classes of consumers who prefer the raw fat for shortening; and there is also a small but growing use of oleo oil in biscuits, crackers, and so forth, since producers of such baked goods are not subject to meat inspection.¹ Only a fairly large local slaughterer, however, is in position to produce oleo oil; moreover, the joint product, stearin, must go to non-food use. In short, unofficial plants possess virtually no outlet for edible fats from cattle, calves, and sheep. The raw materials mainly go to inedible tallow, produced either by the local plant or by "renderers" to whom the materials are sold. In some localities they are fed to hogs or wasted. A portion of the beef fat is also used locally to adulterate lard.

The situation is easier with respect to edible hog fat—lard. Here there is a large local market, both in the household demand and that of wholesale consumer. The biennial census showed that in 1925 the baking industry consumed 369 million pounds of lard and other shortening. The product of the local slaughterer, however, must be sold locally for whatever it will fetch, irrespective of market conditions, and in competition with the widely advertised brands of refined lard of the large packers. Interstate packers assert that their product is driven abroad because of the character of this domestic competition. Probably a disproportionate amount of the local lard goes to wholesale users; and the marketing conditions are such as not infrequently to force it to the price of white grease. From our observation, as well as from statements of brokers, it would appear that not a few

¹ Baked or farinaceous foodstuffs containing animal shortening are not classed as "meat foods" within the purview of federal meat inspection.

unofficial plants make no attempt to produce lard. They make white grease instead, chiefly for the export trade.

So far as concerns inedible fat, local and other unofficial plants are at no disadvantage as compared with federally inspected plants; indeed, in practice, renderers and unofficial slaughterers may enjoy some advantage, under the divided system of regulation, in the marketing of certain inedible animal fats. This arises under the federal regulation that "inedible grease, inedible tallow, or other inedible fat *having the physical characteristics of an edible product shall be denatured or destroyed for food purposes.*" Even the type and quantity of denaturant (power distillate) are specified. Products manifestly unfit for food, by reason of odor or appearance, are not subject to this requirement, but proper labeling is required in any case.

Three complications arise here. In the first place, it is not always easy to differentiate border-line cases, and it is possible subsequently to refine an inedible fat that is manifestly unfit for food use. Full enforcement could be insured only by requiring denaturing of all inedible fats. In the second place, objection to the use of denaturants has been voiced by some large users of these products who compound these fats with mineral oil for lubricating greases and oils. The federal service investigated this objection and reported it to be without foundation; but the preference persists. In the third place, the effective application of the denaturant creates a technical difficulty. The power distillate must be added in the rendering tank. In the process of rendering at high temperatures, often only a trace of the denaturant remains. For this reason, the federal regulations were altered late in 1928 so as to double the quantity of the distillate required. This insures effectual denaturation, but at the same time, according to the trade, it raises the "M.I.U."—the percentage of moisture, impurities, and unsaponifiable mat-

ter—and thereby affects the more generally recognized grades and standards (see Appendix, p. 301).

The regulations just mentioned apply to federally inspected plants, whatever their market. They do not apply to other plants so far as they ship only within a state. It does not appear that many local authorities make or enforce similar regulations. Where they do, a special license or exemption can usually be obtained for special purposes, whereas the federal service can grant no such exemption. Hence in intrastate trade the local plants have a certain advantage in this respect. The regulations nominally apply to those products of local plants that enter into interstate or foreign commerce. But the regulations are manifestly difficult to enforce upon numerous, widely scattered plants not subject to federal inspection. In fact the enforcement rests mainly with the public carriers, who are required to exact a certificate that the product has been destroyed for food purposes. Public carriers, occupied with the business of transportation, are hardly appropriate agencies for enforcement, and indeed are not competent to determine how far the regulation should apply. We are reliably informed that renderers and other unofficial plants, large and small, ship their product (including white grease and prime tallow that may have the "physical characteristics of an edible product") beyond the state line without being denatured. It is inferred that, in such cases, the labels on the tierces, barrels, or tank cars clearly state that the contained product is inedible.

At present these complications, however troublesome they may be to industrial interests and to enforcement officials, appear of no great moment. Within the United States at least no substantial quantities of grease and strictly inedible tallow are likely to go to food uses; however, it is reported that large quantities of fats exported as inedible are subsequently refined for food use abroad. The situation may come, however, to assume a more seri-

ous aspect here. In recent years many improvements have been made in the methods of refining and blending fats and oils. A process has been devised whereby a compound or shortening of fair quality can be made from inferior or low-priced fats, even those of inedible grade. There is a profit incentive, stimulated by the generally accepted view that the process of rendering, involving the application of high temperatures, effectually sterilizes the resultant fat, irrespective of the quality of the raw material. In at least two states the production of such a compound, exclusively for intrastate consumption, has already commenced. The main objection to this development is the danger of abuse; of the utilization not only of a good grade of material from unofficial plants, but also of fats of repellent origin.

One effect of the present situation, then, is to divert large quantities of materials, including fats of the highest grade, to lower-priced industrial use. This, of course, is an economic loss rather than a waste; it is one of the less important consequences, and might perhaps be regarded as a small offset to the undoubted advantages of federal regulation. It is true, also, that local slaughterers usually do not have sufficient volume to warrant the production of oleo or of canned specialties. There are, however, a few large local producers; others, like some small interstate plants, could sell by-products to the large slaughterers, when such are locally available, or could easily render beef and sheep fats for edible tallow; and there seems to be an increasing tendency for small producers to unite for the processing of by-products. Many local slaughterers meet the present situation by selling slaughterhouse offals to renderers. This is especially true of the small retail slaughterers whose kill is in the aggregate very large (see pp. 158-60). Even fairly large local plants adopt this method, for under the existing limitations it is scarcely worth while to operate separate tanks

for rendering edible and inedible fats. Occasionally hog by-products are similarly sold; usually, however, the edible offals from local plants that go to inedible fat are from cattle, calves, and sheep.

Precisely how extensive is this diversion of edible fats to industrial use, it is not possible to determine from the available information. That it is large is evident. Considering cattle alone, it will be noted (see pp. 158-60) that in 1909 the combined retail and local wholesale slaughter, both not subject to federal regulation, was over 4.4 million head. The local wholesale kill trebled between 1909 and 1927; but for the much larger retail slaughter there are no recent data. Under the more specialized technique of the interstate plants, where less of the product is rendered for fats, the average yield of oleo and edible tallow per head is over 25 pounds for cattle. In addition, there has been a large growth in the local kill of calves, sheep and lambs, and hogs.

Some collateral indications of the extent of this diversion to inedible uses may be sought. It seems reasonable to suppose, for example, that a large expansion in the slaughter outside of federal inspection would be reflected in a relatively large growth in the output of inedible tallow. Again, if much of the by-product of such slaughter is sold to renderers, it would be reflected in a disproportionate rise in renderers' tallow. It should be accompanied, also, by a reduction in the slaughterers' output of oleo and edible tallow, per head of slaughtered cattle, calves, and sheep. The slaughterers' output of grease or tallow is much less conclusive for the present purpose because of the number of other factors that affect the volume of such production.

In our analysis of tendencies of production in the several industries which produce inedible fat we shall attempt to keep these collateral implications in mind (see pp. 111-16). It is with the effect of the divided system of

regulation upon the production of fats that the foregoing discussion has been primarily concerned. Other details of federal regulation exert a substantial influence upon the production of fats in inspected plants. To these we shall have occasion to advert later. It seems desirable first to consider the kinds and sources of animal by-product and waste, the derived products, and the methods of production.

CHAPTER II

SOURCES AND VOLUME OF ANIMAL BY-PRODUCT AND WASTE

UPON FARM OR RANGE

It is to be expected that substantial wastes and economic losses should attend an annual slaughter of over 100 million meat animals, and the production, distribution, and consumption of about 16 billion pounds of meat. Yet perhaps no other great industry exhibits so large a proportion of preventable losses of this kind. One of the principal sources is on farm and range, as shown in Table 1 (p. 30). Average yearly losses during 1924-27, from all causes, were 19.2 million animals. Of these, however, a large number were immature animals—11.1 million pigs, 1.7 million calves, and 1.4 million lambs. Compared with the average yearly slaughter under federal inspection, the loss in the case of cattle was over 12 per cent, of sheep and lambs 28 per cent, and of hogs (excluding pigs) only 3 per cent. The total is roughly equivalent to at least 10 per cent of the yearly commercial production of meats and animal by-products.¹ At prevailing prices of animals marketed in the period, the total loss would represent a farm value of over 150 million dollars a year.² In addition,

¹ Only farm wastes or losses that substantially augment the supply of raw materials for inedible fat are here considered. The livestock industry also suffers heavy direct and indirect losses from other causes, notably the cattle tick or fever tick (in the South), contagious abortion, scabies, and the like. Such losses are to be added to those estimated in Table 1. It should be noted, also, that the death-rate of immature animals (which is only partially reflected in this table, which covers only the losses of pigs, and so forth, "saved") represents a heavy reduction in the outturn per head of breeding stock, and a corresponding increase in overhead costs.

² No accurate computation of the loss is possible, for the lost animals were mainly not ready for market, and prices would doubtless have been lower if these animals had all been marketed.

the yearly losses of horses and mules on farms from disease are about 1.5 per cent of the total number, or around 300,000 apart from the loss in cities, for which there are no data.

TABLE 1.—YEARLY LOSSES OF MEAT ANIMALS ON FARM AND RANGE, 1924-27*

(Millions of animals)

Year	Cattle ^a	Calves ^b	Hogs ^a	Pigs ^b	Sheep ^a	Lambs ^b
1924	1.3	1.6	1.5	11.0	2.2	1.3
1925	1.3	1.6	1.3	10.4	2.4	1.3
1926	1.0	1.8	1.3	11.6	2.3	1.4
1927	1.0	1.7	1.4	11.2	2.7	1.5
Average loss	1.2	1.7	1.4	11.1	2.4	1.4
Federally inspected slaughter (average 1924-27)	9.8	5.1		45.0		12.5

* For the data, upon losses we are indebted to the Division of Crop and Livestock Estimates, Bureau of Agricultural Economics. These data (apparently unpublished) cover deaths from all causes, represent a revision of earlier and less adequate statistics of this sort, and are believed to be fairly accurate.

^a In the case of cattle, hogs, and sheep, the figures represent deaths of mature stock of all ages that were on farms January 1 of each year.

^b Data for calves cover losses from all causes, including calves "knocked on the head"; for pigs the data represent losses of pigs "saved," or pigs that have lived several weeks; for lambs the data represent losses of animals "saved"—defined as living June 1 in native sheep states and as "marked" or "docked" in Western sheep states.

From such farm losses the salvage is of small proportions. Physical conditions largely preclude reclamation. Hides, however, are frequently saved. Excluding the hide, the value of a steer for fat, feed, and fertilizer is between \$5 and \$10. Near the cities, where roads are good and other forms of waste are available in sufficient volume to maintain a rendering plant, there is some salvage, mainly of dairy animals.¹ Considerable numbers of such salvag-

¹ Animals affected by certain diseases such as anthrax or the foot and mouth disease must be completely destroyed or incinerated. Normally, however, such losses are relatively small.

ing plants are also to be found in some areas of dense livestock population, notably in Iowa, Indiana, and Ohio. In time, doubtless a larger proportion of the farm wastes will be reclaimed for industrial use. There is a growing shortage of the derived products; while the betterment of roads and increase in the number of towns and cities provide more favorable conditions for reclamation.

The efforts of the federal and state governments to eradicate or control animal diseases entail an annual expenditure of millions of dollars. For the suppression of animal tuberculosis alone the combined federal and state appropriations in 1927 were approximately 17.6 million dollars, compared with about 10 million dollars in 1926.¹ An extensive machinery has been created to prevent the shipment of diseased animals, to effect quarantines, test and certify herds, and to develop methods of cure or control. Nor is such control limited to the movement of animals. Additional costs and economic losses are of necessity entailed by restrictions and quarantines relating to hay, straw, animal feeds, hides, and a number of other sources of contagion.

IN MARKETING LIVESTOCK

The losses in marketing livestock are substantial although smaller than those upon the farm. Upon losses incurred in shipping stock to markets, public or private stockyards, and slaughterers, or in reshipping feeders and stockers, there are only fragmentary data. In 1926 the railroads west and south of Chicago alone reported the payment of livestock claims aggregating \$1,450,855 for such crippled or dead stock. Such claims, it appears, are usually settled on a 50 per cent basis.² Sudden changes

¹ *Agriculture Yearbook, 1927*, p. 49. The federal appropriation of \$4,653,000 for the eradication of tuberculosis from domestic animals was supplemented by state appropriations of approximately 13 million dollars, and numerous agencies gave additional assistance in workers and funds.

² *The National Provisioner*, June 9, 1928, LXXVIII, 25.

in temperature result in a considerable proportion of smothered hogs in hot weather and of frozen hogs in cold. Careless handling and overcrowding also result in damages of various kinds. Nevertheless, losses of this sort have declined on the whole, partly because of improved methods of shipping and also because of the 28-hour law.¹ The growing use of the motor truck has probably been a factor in reducing losses.

In loading, unloading, transportation, and in handling animals at the stockyards, a considerable loss results from bruises and minor injuries which reduce the value of pelts and meat. Seriously crippled animals, "downers," and bruised meats sometimes go to the tank room; there is also some loss at the stockyards through death, as well as an additional and probably a larger loss, prior to sale, from rejections for disease.

The great public stockyards handle the bulk of the shipments. Under the joint operation of the Meat Inspection Act and laws (federal and state) governing the transportation of livestock, these yards are treated in effect as quarantined areas. "Receipts" are generally examined immediately upon arrival. Animals plainly suffering from disease are condemned and slaughtered separately from those passed upon ante-mortem examination. Animals suspected of disease are marked "Suspect," segregated, held for observation or treatment, or separately slaughtered. In the case of a group or "lot" of hogs of which one or more is suspect for hog cholera or swine plague, the entire lot must be similarly segregated and treated as suspect. Animals reshipped to points within the state must usually be accompanied by a certificate attesting freedom from disease, issued by state officials. If reshipped to interstate or export destinations, a similar certificate must be obtained from federal officials. It should be

¹ Under this statute livestock en route to market must be unloaded and given five hours rest with feed and water after having been on the cars continuously for 28 hours. Under certain conditions they may be continuously on cars for 36 hours.

noted, however, that although the great public yards receive the bulk of the meat animals annually marketed, the movement from farm or range directly to the pens of the slaughtering establishments is also of large proportions. Intrastate shipments directly to an unofficial plant, by truck, rail, or water, are not subject to a comparable supervision. The efficiency of supervision in such cases, and the percentage of condemnations or rejections, vary greatly from state to state, and vary also in different parts of the same state.¹

The official examination under the federal Meat Inspection Act is required to be made on the day of slaughter, in the pens of the establishments, or under certain conditions in the stockyards. Since condemnations inflict heavy losses upon slaughterers, buyers are alert to detect unfit animals. For this reason, and because of the examination under the livestock transportation acts, the rejections prior to inspection must reach considerable figures, which may possibly approach the condemnations of "animals and carcasses" on the official meat inspection. It is perhaps significant that at the federally inspected plants condemnations of cattle for tuberculosis are about twice as large as those for all other causes combined. The external appearance of cattle frequently gives little or no indication of the presence of tuberculosis; usually it is detected after slaughter and the opening of the carcass.

In fine, there exist no quantitative data upon the several types of waste or loss in shipping and marketing livestock. The percentage is probably small, but in view of the great number of animals marketed, the absolute figure may reach substantial proportions. Nearly all such dead, dying, or rejected animals are salvaged. They go to renderers, or to the inedible department of the slaughtering plant. In the interstate plants a special permit must be obtained for the admission of such animals.

¹ Shipments from some areas are characterized by a relatively high percentage of condemnations, either of entire carcasses or of viscera and parts of carcasses. Buyers tend to discriminate against stock from such localities, in lower prices and a more rigid examination. Here there is a consequent tendency to ship directly to unofficial plants.

AT SLAUGHTERING AND MEAT-PACKING ESTABLISHMENTS

In their economic and physical setting the meat and by-product departments of the slaughtering and meat-packing industry are so different as to constitute, in effect, two distinct enterprises. The first is a food industry, manipulating relatively costly and perishable materials; the second is essentially a chemical industry, with the characteristics of mass production. The two have developed along distinctly different lines.

In the abattoir and dressed-meat department, operating methods and equipment have long been standardized. Here few improvements of note have been effected for many years. Certain differences do exist: those arising from variations in the volume of business, and from inevitable variations in efficiency. The layout or construction of individual plants also differs somewhat. Most concerns are comparatively old; they have arisen from small beginnings and have made additions or alterations to plant as the business expanded. The more modern plants are better constructed and arranged. By and large, however, the killing and cutting operations are fairly uniform in plants of comparable size. These operations involve the application of manual labor almost exclusively, machinery being confined to such aids as hoisting devices, conveyors or overhead rails, dehairing machines, power saws, and the like. Probably no other American industry of comparable magnitude utilizes so large a proportion of labor. It is a condition that is apparently inherent in the killing and cutting operations. Indeed, the meat-packing industry affords a familiar example of labor highly specialized in its functions.

Quite different is the situation with respect to the elaboration of offals. Here heavy and relatively expensive machinery is employed. It is in the manufacture of by-products that the industry has made its most notable advances within recent years. Hence wide differences are

to be found in the technique and efficiency of different plants. Nevertheless, the products are relatively low priced, and the investment in costly equipment is of necessity conditioned by the volume of materials. For example, a small producer, slaughtering ten steers weekly, would have the opportunity of earning an operating profit upon a gross annual business of roughly \$50,000. Of this figure, the return from meats would be approximately 90 per cent, and the value of hides would represent a substantial portion of the balance.

These two characteristics explain many aspects of the meat-packing industry today—the fact that the slaughtering business is essentially a manual process, necessitating relatively little investment in plant,¹ and the further fact that the conversion of by-products demands a more substantial investment and greater technical ability, or at least a training different from that of the butcher. A butcher with only a modest capital can launch into the slaughtering business. If local authorities permit, a barn and some simple equipment will suffice, including perhaps facilities for refrigeration and for the disposal of sewage. Livestock may be purchased near by, and the locality offers a ready market for fresh meats. Such a producer can usually undersell the distant packer, so far as concerns fresh meats, and tends gradually to expand into a “regional” business, wherein he offers stiff competition to the packer engaged in a national or international trade. The urgency of the by-product problem is lessened by the fact that the great bulk of the revenue is from meats. Moreover, even in respect to by-products a number of factors combine to improve the position of the small or medium-sized plant. Machinery has been improved, simplified, and cheapened; the demand for animal by-products has been growing; and the number of plants specializing in the manufacture of such products—

¹ Particularly in plants not subject to federal regulation.

renderers, glue and fertilizer works, and so forth—has been increasing. Where such plants are locally available the small producer finds a ready market for offals.

It is probably significant that the great packing concerns have been erecting or buying plants at strategic points throughout the country, partially decentralizing their operations. Co-ordination is maintained through a central administrative and technical staff; interchange of products, especially of cured meats and specialties, admits of a more flexible response to local or international market conditions. The operations of the local subsidiaries are less diversified than those of the great central plant, but usually the branches carry a full line of the internationally advertised products of the main plants.¹

A third characteristic of the industry is of importance in respect to the utilization of products. This is the flexibility of its markets, in the sense of the variety of forms in which the products may be marketed. Fresh meats may be sold in sides, quarters, or carcasses, or the carcass may be "broken down" into cuts, the demand for which varies seasonally and locally. Surplus or other meats may be canned, cured, frozen, dried, or sold in the form of numerous specialties. Fats may be sold raw, rendered for one to ten or more grades of commercial fat, which in turn may be split for derivatives, or used in soap, compound, and oleomargarine. Bones are frequently consigned to the rendering tank without any attempt to recover the contained glue and gelatin; they may also be sold as green, commercial, or hard bone, or again, glue and grease or oil may be recovered and the residue sold

¹ The great meat-packing establishments have to contend with higher transportation costs, on raw materials as well as products, must employ a large central and administrative staff for the supervision of many laborers and the handling of many products, and incur, also, a higher overhead. Against these disadvantages are to be set off the benefits accruing from broad markets, flexibility of operations, integration of auxiliary industries, and more effective utilization of by-product. Acquisition of local subsidiaries appears to offer a means of meeting local competition while maintaining some of the advantages of large-scale production and distribution.

as steam bone. Effective utilization is manifestly a relative term; it is conditioned by prices and costs. Nevertheless, from a broader viewpoint the industry is characterized by many economic losses as well as by absolute waste.

The slaughtering and meat-packing industry is commonly cited as a conspicuous illustration of the intensive use of by-products.¹ This characterization is accurate so far as concerns a few great establishments, where masses of raw material admit of the segregation of different types and grades, of heavy investment in equipment, and of the maintenance of a technical and research staff. The characterization is much less true of the average plant, primarily engaged in the business of purveying meats; and it is not at all true of numerous small producers who waste part of the by-product and dispose of part in such ways as local conditions will admit. Moreover, a producer with a large domestic and foreign market possesses outlets closed to the small unit which does only a local business. There are a large number of small retail slaughterers whose methods do not differ materially from those

¹ The terms slaughterer, meat packer, and butcher are loosely used by the trade. Strictly speaking, meat packing means the curing or processing of meats for the wholesale trade. In the current and well-established usage of the trade, however, the less suggestive and presumably more dignified designation, "meat-packing establishment," is inclusively applied to any plant of respectable proportions—to any wholesale plant, in fact—that cures or processes meats or slaughters meat animals. Before the advent of refrigeration, meat packing was a much more important branch of the business than it is today. It is now much less than the business in fresh meats. The current usage is somewhat unfortunate. While commonly slaughtering, curing, and processing are done in the same plant, there are many so-called packers who merely operate an abattoir—slaughter meat animals for the trade in fresh meats and do little or no curing. There are also many concerns that pack without slaughtering, buying unprocessed or fresh raw materials known as "green meats." There are many indications that specialization of this and other sorts is now becoming more frequent than it has been.

In short, "meat packer" is now the inclusive designation for wholesale slaughterers or meat packers. The designation "butcher" is generally applied to the operator of a small abattoir, mainly to supply a retail or local trade with fresh meats. It is also applied, of course, to one who is merely a distributor—conducts a meat market—as well as to a class of workmen in packing plants and meat markets.

formerly employed by the typical country butcher. In 1909 the kill of such retailers was over 13 million head. Again, there is obviously a large waste in the farm kill, over 19 million head in 1919. In those years the combined retail and farm kill was about 40 per cent of the total. Particularly in these two classes of slaughter there are economic losses of various kinds and a large waste of by-products such as blood, bone and other grease, glue and gelatin, and so forth. Blood, for example, is a valuable fertilizer and feed because of its high nitrogen content. The yield of green or unprocessed blood per animal is approximately 40 pounds for cattle, 6.1 for hogs, and 3.9 for sheep.

We have already remarked that a considerable economic loss results from the lack of co-ordination between federal and local meat inspection. By restricting the market of the local slaughterer, it forces several hundred million pounds of edible products to lower-priced inedible uses.

STATISTICAL NOTE

For the industry as a whole, only fragmentary data are available concerning the production of meats and by-products. It is therefore not possible to compare actual with potential recovery. Table 2 (p. 40) affords a rough notion of the potentially available volume of the primary products of the industry. It has been constructed by applying to the official estimates of total slaughter the percentages of the various products reported by one of the largest and most efficient plants. Consequently, it represents not actual but potential yield, according to modern packing-house practice. However, a comparison of the percentages of the various products, as given in this table, with such as are officially reported for the federally inspected plants (see Table 10, p. 129) indicates a rough agreement on the whole. The chief disparity is found in the proportion of the hog carcass that is assigned to

dressed pork and lard, respectively.¹ Of other dressed meats, yields are somewhat higher in this table, because in general the large plants kill animals of better quality; and yields of edible offals are somewhat higher owing to the economic and regulatory conditions already discussed. Much more variation would be found if yields reported in this table were compared with those for unofficial plants and farm slaughter. For these, however, there are no data.

The magnitude of the industry is reflected in the huge totals in Table 2. It will be observed that in 1928 the total slaughter numbered 115 million animals. Stated in monetary terms, for a notion of the relative importance of this raw material, its value was around 3 billion dollars.² The wholesale value of the derived meats and animal products must be, roundly, 4 billion dollars. The retail value is of course much higher.

Summarizing a few of the salient data in Table 2, it will be noted that the gross live weight was 32 billion pounds in round figures; that shrinkage (evaporation, valueless materials, and so forth) averaged about 25 per cent, leaving over 24 billion pounds of available product. About 75 per cent of

¹ Some of the fat parts which ordinarily go to fat backs, and to other cuts reported as dressed meat, are at times rendered for lard. (Fat backs are about 9.5 per cent of the live weight, or about 23.75 pounds in a 250-pound hog.) The quoted trade source gives the ordinary lard yield as 9 per cent of the live weight; the official report for the federally inspected plants gives a yield of about 15 per cent. This difference of about 6 per cent results in a shift of a billion pounds in the respective yields of dressed pork and rendered lard. Lard being relatively low priced, and involving, also, an additional manufacturing process, doubtless as much of the carcass goes to meats as market conditions will permit. For the industry as a whole, the quoted 9 per cent appears to be too low; on the other hand, for reasons indicated in footnote *d* to Table 2, we incline to the view that the official estimate of 15 per cent for lard is much too high. Moreover, it is hardly likely that in the large farm kill (nearly 7 million head) the lard yield is as high as 14 per cent, the percentage applied in the official estimates of farm lard. Probably the percentage of lard recovered is somewhere between these two figures, with a corresponding adjustment in the yield of dressed pork.

² By applying to the total slaughter the average prices officially reported as having been paid by the interstate plants, which account for about two-thirds of the annual slaughter, one gets a figure of 3.24 billion dollars. Doubtless the unreported prices paid by "unofficial plants" and the value of the farm slaughter should be calculated at lower averages. Approximately the same results would be obtained for the year 1927.

INEDIBLE ANIMAL FATS

TABLE 2.—ESTIMATED POTENTIAL YIELD OF MEATS AND PACKING-HOUSE BY-PRODUCTS, 1928

Item	Total	Cattle	Calves	Sheep and lambs	Swine
(Million animals)					
Total slaughter ^a	115.1	12.5	8.7	17.3	75.6
(Million pounds)					
Live weight ^b	32,310	11,804	1,525	1,421	17,560
Shrinkage ^c	7,997	3,494	473	430	3,600
Available product ^c	24,313	8,310	1,052	991	13,960
Dressed meat ^d	18,370	6,421	834	711	10,404
By-products	5,943	1,889	213	280	3,556
Edible	3,688	673	64	54	2,897
Miscellaneous meats ^e	1,830	425	58	30	1,317
Oleo oil and stearin.....	278	248	6	24	....
Lard	1,580	....	....	....	1,580
Inedible	2,255	1,216	154	226	659
Hides or pelts	945	697	102	146	....
Bones, hoofs, and horns.....	174	153	12	9	....
Tallow, grease, and oil.....		59	6	9	
Blood, dried		177	6	10	
Tankage	1,136		23	24	659
Casings		71	....	8	
Miscellaneous		59	5	20	

^a Total slaughter from U.S. Bureau of Animal Industry, *Meat Production, Consumption, and Foreign Trade in United States, Calendar Years 1900-1928*.

^b Live weight per animal is the weighted average for the year 1928 for federally inspected plants (*Crops and Markets*, February 1929, VI, 57) here applied to the total slaughter to obtain total live weight. A lighter class of animals goes to the unofficial plants; but according to the quoted source the interstate plants account for about two-thirds of the total kill, and the percentage of error in the gross weight is not large.

^c Shrinkage and the percentage of the various products (finished weight) from different classes of animals is from data made available through the courtesy of Swift & Company. Other data in Table 2 have been computed by applying these percentages to the gross live weight, calculated above.

(See footnotes *d* and *e* on opposite page.)

TABLE 2 (Continued)

Item	Total	Cattle	Calves	Sheep and lambs	Swine
	(Pounds per animal)				
Live weight	947.9	175.9	81.9	229.3
Shrinkage	280.8	54.5	24.8	47.0
Available product	667.3	121.4	57.1	182.3
Dressed meat ⁴	515.7	96.2	41.0	135.9
By-product	151.6	25.2	16.1	46.4
Edible	54.0	7.4	8.1	37.8
Miscellaneous meats ⁴	34.1	6.7	1.7	17.2
Oleo oil and stearin.....	19.9	.7	1.4	.....
Lard	20.6
Inedible	97.6	17.8	13.0	8.6
Hides or pelts	55.9	11.8	8.4	.....
Bones, hoofs, and horns.....	12.3	1.4	.5	.....

⁴ The dressed weight per animal (and therefore total dressed meat) calculated as above tallies fairly closely, except for swine, with yields actually reported by the federally inspected plants:

Average dressed weight per animal	Cattle	Calves	Sheep and lambs	Swine
As calculated in Table 2.....	515.7	96.2	41.0	135.9
As reported by official plants..	507.5	98.8	38.8	172.8

It will be observed that the only material disparity appears in swine. We find that the official report for the dressed weight of hogs (interstate plants) is inclusive of carcass fats, subsequently trimmed, rendered, and duplicated in the reported lard output. In the official estimate for dressed pork an adjustment is made for this duplication by means of a constant and unexplained formula, reducing dressed pork per animal from 172.8 to 121.9 pounds (year 1928), compared with the 135.9 pounds given in this table.

It is probable that in the official figures the adjustment for lard and the official estimate of lard production are both excessive. Much unrefined lard is bought by the large packers, refined, and reported by them as "production," thus entailing duplication. Moreover, the official figure is based upon "inspected pounds." Such lard would be inspected and counted twice or more. Again, unrefined lard is inspected and stored; and may be again inspected when refined and withdrawn for the market. The situation is complex; the figure supplied by Swift & Company is probably too low, and the other too high. It involves a disparity of a billion pounds, more or less, in the figures assigned to dressed pork and lard respectively. See also footnote 1, p. 39.

⁴ Includes tongue, heart, liver, tripe, head and cheek meat, tail, brains, sweetbreads, lips, and palate.

INEDIBLE ANIMAL FATS

TABLE 2 (Concluded)

Item	Total	Cattle	Oalves	Sheep and lambs	Swine
Tallow, grease, and oil.....	.....	4.7	.7	.5	} 8.6
Blood, dried .....	.....	} 14.2	.7	.6	
Tankage .....	.....		2.7	1.4	
Casings .....	.....	5.7	.....	.5	
Miscellaneous .....	.....	4.8	.5	1.1	
(Percentage)					
Live weight	100.0	100.0	100.0	100.0	100.0
Shrinkage	24.8	29.6	31.0	30.3	20.5
Available product	75.2	70.4	69.0	69.7	79.5
Dressed meat ^d	56.8	54.4	54.7	50.0	59.2
By-product	18.4	16.0	14.3	19.7	20.3
Edible	11.4	5.7	4.2	3.8	16.5
Miscellaneous meats ^e	5.7	3.6	3.8	2.1	7.5
Oleo oil and stearin .....	.....	2.1	.4	1.7	.....
Lard .....	.....	.....	.....	.....	9.0
Inedible	7.0	10.8	10.1	15.9	3.8
Hides or pelts .....	.....	5.9	6.7	10.3	.....
Bones, hoofs, and horns.....	.....	1.3	.8	.6	.....
Tallow, grease, and oil.....	.....	.5	.4	.6	} 3.8
Blood, dried .....	.....	} 1.5	.4	.7	
Tankage .....	.....		1.5	1.7	
Casings .....	.....	.6	.....	.6	
Miscellaneous .....	.....	.5	.8	1.4	

(See footnotes *d* and *e* on page 41.)

this available product, or 56.8 per cent of the gross live weight, consisted of dressed meat. Pork and beef account for about 90 per cent of the domestic production of meats.

Current estimates of total and per capita meat consumption are based on the estimated yield of dressed or carcass meat. No account is taken of edible offals. It will be observed from this table that the yield of such offals ("miscellaneous" or "fancy" meats) reaches the substantial figure of 1.8 billion pounds, or about 15 pounds per capita. It is a familiar fact that the domestic consumption of such edible by-products as liver, kidneys, and the like has been increasing, per-

haps because of the therapeutic properties now claimed for such foods.

Total by-product is nearly 6 billion pounds, equivalent to 18.4 per cent of the live weight and about 25 per cent of the recovered product. Of this by-product, about 3.7 billion is edible (offals and food fats) and 2.2 billion inedible, the last figure being 7 per cent of the live weight. The data, as previously stated, represent primary by-product. Excepting lard, of which approximately two-thirds is rendered from carcass fat, they represent the yield from "rough offals" or "killing offals." These are terms used to distinguish products removed from the slaughtered animal in the course of dressing, from trimmings, bones, and fat removed in the process of dividing or cutting in the boning or cutting department, or in such processes as curing, canning, and sausage making. Only in the case of hogs, however, is such dividing extensively done at the packing plant. In cattle, rough offals consist of head, blood, feet, viscera and glands, hides, and so forth.

In certain respects the figures for primary by-products given in Table 2, nearly 6 billion pounds, understate the truth. They assume that all animals slaughtered are sound, and that all the meats are salable as such. The yield of by-products is much larger, unit for unit, from condemnations, which in official establishments are around 250,000 carcasses¹ and a million primal parts of carcasses, as well as a large number of condemned viscera not reported. There must also be added the yield from spoiled meats, as well as from trimmings, fats, and bones from the cutting and curing operations. Moreover, the data given represent yields upon the basis of modern packing-house practice; and it is probable that by-product yields are larger in the small or inefficient plants. Accordingly, it seems probable that the potential yield of primary by-product is considerably larger than 6 billion pounds. But by no means is all of this material fully utilized, and conceivably the figure given may approximate the actual yield.

¹ Indeed, these appear not to be included in the slaughter statistics.

IN MARKETING AND CONSUMPTION

Wastes arising in the course of distribution and utilization are very large. The wastes of retail markets, hotels, and restaurants constitute a considerable portion of the raw material of the renderer. A rough notion of the volume of unsalvaged waste may be gained from the fact that, while the renderers' output of fats, tankage, and so forth, is about $1\frac{1}{4}$ billion pounds, there are large sections of the country in which renderers are few or nonexistent. Moreover, renderers do not find it profitable to collect kitchen or household waste. Such waste amounts, in cities, to about 250 pounds per capita (see p. 218), or perhaps 20 billion pounds per annum, with a potential yield of 4 to 5 billion pounds of grease, feed, and fertilizer. In many localities garbage is fed to hogs. Most of it is incinerated or dumped into rivers or the sea. Although reduction works for the conversion of such materials into grease and fertilizer have in a number of instances proved to be profitable, only a few cities maintain such plants. Their total output of grease and tankage is approximately 250 million pounds. Upon the basis of a per capita "production" of 250 pounds of garbage, the annual yield of greases, by present methods of extraction, amounts to about 7 pounds per person. The yield of fertilizer tankage is much higher. A conservative estimate would indicate a combined yield of the two of about 40 pounds per person.

To conclude: We have here attempted to sketch, in rough outline, the sources and volumes of the various classes of reclaimed and unreclaimed animal by-products and waste, reserving details for later consideration. At the one extreme, in the first and last steps in the process of production and utilization, are the farm losses and the household wastes. Such wastes are huge, and in considerable part represent virtually a complete loss of utility.

At the other extreme, in the large slaughtering and meat-packing establishments, the utilization of by-products is generally efficient. Between these two there are several gradations of effective reclamation. Unused wastes in farm and retail slaughter are evidently large. It is plain, however, that the business of salvage is still in its infancy; and it is probable that our initial estimate—that the aggregate of the varied unused animal products is equivalent, in poundage, to as much as one-half the amount actually utilized—is a conservative one. In terms of value, evidently the aggregate of such wastes, and of the varied economic losses, is relatively much less. In chapter iv the commercially available wastes and the materials actually recovered will be considered in some detail.

CHAPTER III

PRODUCTS, THEIR USES, AND METHODS OF MARKETING

ANIMAL BY-PRODUCTS

The products derived from animal offal and by-products, hundreds in number, fall into the three classifications of food, industrial, and medicinal or pharmaceutical products. Typical foods from killing offal are hearts, brains, sweetbreads, liver, and tripe. Certain rough offals, as well as by-products from the cutting or curing department, also go to edible fats, and supplement boned meats, pork shoulders, and the like in canned goods, sausage, and similar preparations. Of industrial and medicinal products illustrations may be drawn from the following partial classification of such commodities:¹

Products from wool, hair, and hides.—All kinds of leather, brushes, binder in plaster, felt, padding, hair for upholstering furniture and for mattresses, glue, and lanolin.

Products from sinews, fats, and blood.—Blood meal, albumen, filler for leather, fertilizer, meat meal, illuminating and lubricating oils, glue, . . . gelatin, isinglass, benzoinated lard, lard stearine, . . . [grease], and tallow.

Products from glands and viscera.—Sausage casings, gold-beaters' skins, perfume-bottle caps, tennis strings, clock cords, drum snares, violin strings, surgical ligatures, pharmaceuticals.

Products from bones.—Combs, buttons, hairpins, umbrella handles, napkin rings, tobacco boxes, buckles, crochet needles, knife handles, dice, chessmen, electrical bushings,

¹ R. A. Clemen, *By-Products in the Packing Industry* (Chicago: University of Chicago Press, 1927), pp. 6-7.

washers, artificial teeth, bone rings for nursing bottles, glue, case-hardening bone, gelatin, fertilizers, oils, soap grease, [animal charcoal].

Pharmaceuticals.—Pepsin, pancreatin, thyroid extract, adrenalin, benzoinated lard, pituitary liquid, pineal substance, thrombo-plastin, red bone marrow, [liver extract].

These commodities are the product of a complex group of by-product industries. Only in several great meat-packing establishments has integration been carried to a high degree; and even here these by-products are produced either in subsidiary concerns or are transferred to semi-independent departments of the plant, distinct from the slaughtering business proper. Specialization is more notable in the field of industrial products. It will be observed that most of these are derivatives of a few primary by-products: namely, of pelts, wool, and hair; casings, bladders, and so forth; bones; fats; and blood.

The production of inedible animal fats is an integral part of the industries concerned with the primary salvage of animal by-products and meat wastes. Two of these, comprising rendering plants and municipal reduction works respectively, produce inedible animal fats as a major product. Large quantities are incidentally produced in the slaughtering and meat-packing establishments. For the present purpose, chief consideration must be given to these three industries, since relatively insignificant quantities of fat are produced in other and somewhat related industrial groups.¹ Of necessity, however,

¹ Producers of glue and gelatin utilize bones, hide trimmings, and so forth, obtained from slaughterers, renderers, and tanneries, use some quantities of junk bones directly obtained from scavengers, and produce some grease as a by-product. Compounders of mixed feeds and fertilizers purchase tankage, cracklings, bone meal, and so forth, from slaughterers and renderers, and incidentally extract some grease. Manufacturers of bone char or bone black, a product mainly used in refining sugar, in decolorizing liquids, and in refining vegetable oils, utilize bones purchased from similar sources and produce some bone grease as well. Sausage kitchens, furriers, and wholesale provisioners also produce small quantities of grease.

an adequate presentation of the subject must include some treatment of what in some sections is an important competitive use of the raw material, the extensive feeding of animal wastes to hogs. This delineation of the field seems necessary to afford a clear view of the trend of the following discussion.

GENERAL CHARACTERISTICS OF THE INEDIBLE FATS

The commercial term "inedible animal fat" is virtually equivalent to animal greases and inedible tallow, for these constitute about 95 per cent of the total domestic output of such primary inedible fats.

Between inedible and the corresponding edible animal fats no sharp distinction can be drawn. Some rendered fats classed as inedible, for example, from condemned animals, are practically indistinguishable by the senses from edible grades unless they have been denatured. Even when manifestly of inedible grade, they can frequently be so modified by refining methods, where this is permitted, as to make them acceptable as edible products.¹ These methods are the same as those to which nearly all vegetable oils are subjected in preparation for food use. Indeed, rendered fat is commonly sterilized in the course of extraction so that the conditions under which it was produced are less significant than if this were not the case. Furthermore, much of the edible beef and sheep fat of the slaughterers who do only a local or intrastate business (and are therefore not under federal inspection) is forced to non-food uses, since only federally inspected fats and meat foods may go into interstate trade.

In practice the difference between food and industrial fats is partly one of gradation in quality, partly one of esthetic considerations, and partly the result of sanitary

¹ This is not permitted in plants subject to federal meat inspection. State and local conditions vary; and it is reported, also, that abroad inedible fats are to some extent refined for food use. See also below, pp. 274-75.

control. A large proportion of the product advertises its inedibility to the senses by odor, flavor, and color. Chemically a high percentage of free fatty acids¹ usually characterizes inedible fats and distinguishes them from edible grades. In establishments under federal inspection, as we have seen, any inedible fat which has the character of an edible product is required to be denatured. Other establishments cannot be required by any federal agency to denature inedible or non-federally inspected fats, but the interstate shipment of such undenatured and uninspected materials would probably constitute a violation of the federal Meat Inspection Act. State and local regulations vary.

Nor is the distinction between inedible tallow and grease clear-cut today. According to former usage, tallow was the fat of cattle, calves, or sheep, and grease was the fat of hogs. Meat packers contend that this usage should be preserved, but the distinction no longer holds. Of the total of the two classes of fats, more than half is now produced outside of the packing house, and from a heterogeneous class of materials. If the sources could be fully traced, it would doubtless appear that most of the market tallow is derived from cattle, calves, and sheep, and the bulk of animal grease from hogs. But even in the packing house, and much more so outside, some materials for tallow and grease are intermingled; and some packers collect and render outside wastes, competing with renderers in this salvaging business. Grease is extracted from a wider range of materials; its quality varies more widely, and it is sold under a large number of grades. The lower grades of tallow are not readily distinguishable from grease.

From the standpoint of consuming trades, the distinction between tallow and grease is one of consistency. A

¹ Cf. C. L. Alsberg and A. E. Taylor, *The Fats and Oils: A General View* (FATS AND OILS STUDIES OF THE FOOD RESEARCH INSTITUTE, No. 1), February 1928, p. 4.

tallow is hard in body at ordinary temperatures; a grease is soft. To consumers of inedible fats the titre test yields an index of differences in consistency, and appears largely to reflect basic differences for purposes of utilization.¹ "The 'titre' of a fat or oil is the temperature at which the mixture of fatty acids derived from it solidifies after it has been melted." Roughly speaking, the higher the titre, the harder the fat. Tallow has a titre of 40° to 45° C. (104° to 113° F.); grease, a titre of 37° to 39.5 C. (98.6 to 103.1 F.). Both may have a free fatty-acid content of from as low as 1 to as high as 60 per cent.

Inedible animal fats are purchased on sample or upon the basis of stated specifications in the contract of sale. They are graded by color, titre, the amount of moisture, impurities, and unsaponifiable matter (abbreviated to M.I.U. by the trade), and percentage of free fatty acids. Color is read by the Lovibond color glasses; other factors are determined by chemical analysis. A product of a white or light color usually commands a price premium, partly because the soap trade (the largest single consumer) prefers a white product, and also because in general a light color indicates superior quality in other ways; e.g., the lighter the color the lower, in general, is the percentage of free fatty acids. Animal matter decomposes rapidly at ordinary temperatures. Moisture and other impurities accelerate decomposition, reducing yields of dry product and increasing costs. In decomposition the fat breaks down, splitting the glycerin away from the fatty acids and forming "free fatty acids." This is usually attended by a loss of glycerin, which ordinarily constitutes about 10 per cent of the weight of the fat. Likewise part of the nitrogen in the animal matter treated is volatilized and freed, reducing the ammonia or protein content of the tankage.

The fat from putrefying or rancid materials will be high

¹ The Bureau of the Customs has ruled that any animal fat testing 40° C. or over shall be classed as tallow, regardless of the content of hog waste or grease, and regardless of color, odor, or rancidity. The ruling was made after testimony by meat packers and soap-makers, in connection with the tariff rate applicable to imported fat.

in free fatty acids, and the yield of the valuable derivative, glycerin, varies inversely with the percentage of such acids. Emphasis on the various factors of quality, however, varies with different classes of consumers. The titre test by which the content of solid fatty acids is estimated is of especial importance to stearic acid and candle manufacturers, and to small producers of soap not equipped with hydrogenating facilities.¹

The number of grades and the quality of the product of different establishments are both conditioned by the volume of available raw material. A small producer does not find it profitable to imitate the specialized methods of the large units. For example, such a producer finds it impracticable to segregate small quantities of different classes of material and render them separately; and raw fats deteriorate rapidly in the process of accumulation. Indeed, not a few small plants produce a single grade, usually designated as tallow, from a heterogeneous mixture of beef and hog fats, butchers' trimmings, dead horses, and the like. Partly for this reason, and partly also because of the widely varying requirements of consumers, different nomenclatures for grades and varying standards prevail in different sections of the country. Often the buyer is familiar with the plant in which the product originates and knows approximately the sources of the raw material used and the grade that he will obtain. Inedible fats produced by the larger packers go to a large extent to subsidiary concerns such as soap works. Fats not so disposed of, together with the production of smaller concerns, of most renderers, and of municipal reduction plants, are commonly sold on the basis of New York or Chicago

¹ See Appendix A, pp. 301-4, for a description of the various grades, and a comparison of prices of the respective grades for a series of years. The foregoing standards, it should be noted, apply to the primary fats, tallow and grease. For a wide variety of specialized uses—notably different kinds of lubricants, metal cutting and stamping, and burning and signal oils—the primary fats are further selected and processed to meet exacting standards based upon viscosity, flash point, burning or fire point, cold and cloud test, specific gravity, saponification number, Baumé, and so forth. The production of grease and tallow derivatives (animal oils, stearin, stearic acid, sulphonated oils, phenolated oils, acidless oil, soluble oil, and the like) engages several specialized chemical industries. These products are also made by several of the large packers and renderers.

quotations, subject to discount, depending upon location of plants. However, chiefly because of the lack of uniformity in grades, prevailing differences in prices in different sections of the country often materially exceed costs of transportation.

Sales are made either through brokers, for both domestic and export trade, or directly to domestic wholesale consumers; principally to soap and candle makers, compounders of lubricants and cup greases, and to producers of derivatives—red oil, stearic acid, glycerin, tallow oil, grease oil, and inedible stearin. The brokerage charge is $\frac{1}{2}$ to 1 per cent.

GREASES: DESCRIPTION AND USES

The slaughtering and meat-packing industry produces slightly more than half of the domestic output of animal greases. Packers' grease is primarily the fat of hogs which for any reason is regarded as inedible. Outside the packing house any inedible fat may be called a grease if it has a soft consistency like lard. Such non-packer grease is usually described according to origin. Thus garbage grease is mainly made in municipal reduction plants, from household garbage; house grease is extracted from wastes collected from restaurants and hotels; and naphtha or extraction grease is produced from partially degreased tankage or cracklings, obtained from small or inefficient producers. Extracted from nondescript and partially decomposed materials, such fats are of inferior quality, although advances in the technology of fats and oils have developed a wide and growing field of uses for waste or low-grade greases. The packers' product, on the other hand, is extracted from a comparatively homogeneous class of materials, is more uniform and superior in quality, and a large proportion of it is classified under the higher-priced grades. Grease consisting of hog fat is preferred for some uses, and a distinction is made in the trade between packing-house and other greases, price quotations being sometimes accompanied by the statement that the product contains only hog fat.

The packing-house product (and also that of a few renderers who receive large numbers of dead or condemned hogs) is graded as white, yellow, and brown grease, and several subgrades are recognized in the first two classes. White grease of excellent quality, if not denatured, may be practically indistinguishable from lard. It is white or light in color and low in free fatty-acid content. This grade is made from clean and fresh material, rejected for lard or pork products because of some form of contamination. Yellow grease is made from contaminated, condemned, or decomposed materials that are not or cannot be thoroughly cleaned, and therefore yield a darker product, higher in free fatty-acid content. The inferior grade known as "brown" is made from refuse materials, sweepings, catch-basin accumulations, and the like. It is too dark to be read with the Lovibond color glasses, and its free fatty-acid content is high.

No single large source furnishes the chief raw material for any of these grades. Each grade is produced from a varied class of animal material; and the segregation of the raw materials varies in different plants, and varies, also, in individual plants according to the daily kill, prices of the respective grades, and the like. If a dead or condemned hog (not decomposed) is tanked in its entirety, it produces yellow grease. If eviscerated, the carcass produces white grease. The viscera of such hogs, as well as the large number of viscera condemned on the killing floor, likewise produce white grease if hashed and thoroughly cleaned of manure and contaminating materials. Otherwise, such materials produce yellow grease. Some materials cannot be thoroughly cleaned, and therefore go to yellow or brown grease. The volume of some plants does not warrant the installation of mechanical hashers and washers, and these processes must then be performed by hand, or omitted. Moreover, the processes of evisceration and cleaning of such inedible materials must be performed in a room quite separate from those devoted to the production of edible products; and the pipes or conveyors must be sealed to the satisfaction of the meat inspection officials, to make sure that such materials are not diverted to food uses. If the equipment is of such a character that

large numbers of seals are necessary, such hashing and cleaning is not permitted. Again, some plants will separate catch-basin accumulations into a yellow and brown grease; others will extract only a single grade of brown grease from such materials. Because of fluctuations in the daily kill, or in the number and character of condemnations, it may not pay to segregate and separately render the various classes of material, accumulation of which is limited by rapid decomposition. For such reasons, some large plants produce all the various grades and subgrades; others will produce only a white and a brown grease, and so forth.¹

Bone greases (and bone tallow), produced in meat-packing plants and in glue and gelatin works, are not usually sold under this classification; they are generally mixed with other classes of rendered fat. Bones are partially degreased by slow cooking in open vats, the fats being skimmed off, and the residual raw or packer bone processed for glue and gelatin, or sold for commercial bone. When thoroughly disintegrated by steam-pressure cooking and the fat more completely removed, the residue is a fertilizer tankage or meal known as steam bone. The fat from clean, fresh bones is of edible quality. Most of the bone grease, however, is an inedible by-product of glue and gelatin manufacture.

The bulk of the grease consumed in the United States goes to "pressers" and stearic acid manufacturers.² The

¹ In the main, white grease is produced from the following packing-house materials: dead hogs in good condition from the stockyard pens (eviscerated); condemned hogs from killing operations (eviscerated); condemned viscera and black guts, hashed and washed; pigs' feet; nose bones; sawdust from the ethmoid and turbinated bone machines; eyebrows and ear drums; floor sweepings from trimming and cutting room; bruised meats from trimming and cutting room; sausage-room wastes; skimmings from wash-room salt-pickle vats; condemned hog skulls. Some white grease is also produced in serum plants, from discarded hogs; also in glue and gelatin plants, from pigs' feet and skins, and so forth. Yellow grease is obtained from decomposed dead hogs and decomposed dead cattle; condemned cattle and condemned hogs with guts and all contained manure; catch-basin skimmings; skimmings from stick-water vats; condemned viscera, not hashed and washed; hide trimmings, hair and all; sausage-room waste of colored products; knuckle bones from neatsfoot oil; sour bottoms from neatsfoot oil. A good deal of yellow grease also comes from glue and gelatin plants, and from reprocessed cracklings.

² This is indicated by a comparison of the total output of lard oil, grease stearin, red oil, stearic acid, and glycerin with the output of grease. Soap accounts for nearly all of the inedible tallow.

former fractionate it into two portions by melting, cooling slowly, and expressing the oil from solid crystals in a powerful press. The solid portion is grease stearin or inedible lard stearin; the liquid portion is grease oil or inedible lard oil. Different grades of grease or lard oil and stearin are extracted from the several grades and subgrades of grease (see Appendix, pp. 303-4). These oils possess characteristic properties which render them especially valuable to certain industries. They are non-drying, thus differing greatly from most vegetable oils; they possess, also, the important properties of oiliness and viscosity. Even a small admixture of lard oil greatly increases the ability of a mineral oil to overcome friction. Grease or lard oils are mainly used in machine shops and factories as high-grade lubricants and coolants in drilling and polishing metals, by oil companies in cylinder oils, by woolen mills in making soap emulsions, by the leather industry, and in a variety of minor ways. Part of the primary grease, as well as grease stearin, goes to soap, lubricating compounds, cup greases, and so forth; and a considerable proportion of grease and grease stearin is used in the manufacture of the three joint products, red oil or oleic acid, stearic acid, and glycerin. Red oil is highly esteemed as a textile soap base, for fulling and scouring wools, and is also used in lubricating and cutting compounds. Stearic acid mainly goes to the manufacture of candles, often to be mixed with paraffin; it is also used in buffing compositions; and the purest varieties go into shaving creams, vanishing creams, and other toilet preparations. A considerable proportion of the domestic supply of stearic acid is now used as an ingredient in rubber compounds. There is a large export trade in grease and its derivatives.

The edible counterpart of grease is lard. Lard is fractionated in the same way as grease, yielding a liquid portion, edible lard oil, and a solid portion, lard stearin. Edible or "prime winter strained" lard oil, a relatively high-priced product, is chiefly used for burning or signal oils, and, to some extent, by bakers for greasing pans. Lard stearin is used in a variety of ways, among others as

an addition to naturally soft lard to stiffen it, especially for shipment to warm climates.

TALLOW: DESCRIPTION AND USES

Tallow is, in the main, the fat of cattle or sheep. Mutton tallow is harder—richer in stearin—but is characterized by a strong animal odor, and is more liable to rancidity. Beef tallow from the better grade of materials is light in color, nearly tasteless, and its odor is much less pronounced. In the United States the total yield of fat from beef animals is at least ten times as large as that from sheep. In international trade a distinction is made between these two classes of fat. In American practice they are usually blended. In the large official establishments the better grades of the two are blended for oleo stock, the highest-priced tallow. About 5 per cent of caul and ruffle fat from sheep is blended with beef fat in No. 1 oleo, and other fat of this grade goes into a No. 2 oleo. The remainder, as well as most of the product of plants which make no oleo, goes to "inedible tallow." Cattle fat, on the contrary, may be closely classed as "edible" or "inedible" tallow, according to its external characteristics or the conditions under which it was produced.

The inedible tallow of the packers is generally sold in three grades—as "prime," "Number One," and "Number Two," sometimes termed brown grease. Most of the packers' product is of the grade "prime." Like white grease, it is rendered from the best grade of clean, fresh materials rejected for edible fat or beef because of some form of condemnation. Renderers' tallow is variously designated in different sections of the country; sometimes as simply "Renderers' Tallow," "City" and "Country Tallow," or under sub-grades such as "prime," "A," and "B." "City Tallow" is produced from materials daily collected and rendered. It is a better and more uniform product than "Country Tallow,"

the raw materials for which are collected at intervals and often permitted to accumulate. This fat varies greatly in factors of quality such as color and free fatty-acid content.

The great bulk of the inedible tallow is directly used in soap (p. 255). Relatively small quantities are converted, by graining and pressing, into the derivatives, tallow oil and tallow stearin. A product known as "acidless tallow oil" is pressed from prime tallow, and neutralized by treating with caustic soda solution. This product is used by mineral oil companies for compounds, while the stearin or "cylinder tallow" is used for packing the cylinders of heavy engines.

Neatsfoot oil stock, a tallow of good quality, is obtained from the leg bones and feet of cattle, from the knee down. Such bones are washed, trimmed, sawed, and the sinews and hoofs removed. The remaining shin and leg bones are cooked in an open vat, the fat skimmed off, strained into a steam-jacketed kettle, and heated to about 240° F. (115.6 C.). The resulting product, again filtered, is neatsfoot stock, which is pressed for neatsfoot oil and stearin. This oil is much prized for its leather-softening, waterproofing, and preserving qualities. It is also a high-grade lubricant. A second grade is obtained from the regrained and pressed stearin, and the stearin from the second pressing is usually added to prime (inedible) tallow. These oils are always labeled as "pure neatsfoot oil" to differentiate them from the ordinary oils of this kind, which are really grease oils, obtained by the process of graining and pressing greases already described.

Edible tallow is commonly called oleo stock (*premier jus*). In selection of raw materials and processes of extraction such stock parallels neutral lard. Oleo stock is made from the choicest fats of the carcass. These are mainly the killing fats—the caul, ruffle, and the fats obtained from trimming the viscera—but the best grade of cutting fats from the cutting and boning operations are also used. The raw material is carefully handled. It is washed, thoroughly chilled, hashed, and promptly rendered at comparatively low temperatures—not to exceed 170° F. (76.7 C.) under the regulations of the Meat Inspection Service. The fat in the remaining scrap or "bottoms" is either skimmed and remelted

with the next batch, or pressed for tallow. The residual material is tankage.

A small part of the oleo stock is exported or used as oleo stock, principally in the manufacture of oleomargarine. Most of the oleo stock, however, is fractionated, like lard. The solid portion, oleostearin, has a titre of about 50° C. (122° F.). It is principally mixed with refined cottonseed oil and other soft oils in the manufacture of shortening (lard compound). Some quantities are also used by tanners in the production of leather. The softer portion, oleo oil, has a titre of about 41.5 C. (106.7 F.) or slightly higher than neutral lard. It is of a sweet or "buttery" flavor, and keeps well. Oleo oil is chiefly used in making oleomargarine; but growing quantities are used as shortening, especially in the baking of crackers and biscuits. It is also exported in large quantities.

The nomenclature of the trade must be kept in mind in studying trade statistics. Oleo stock, though the highest grade of tallow, is not reported as tallow but always as oleo stock or as oleo oil and oleostearin. In practice the term edible tallow is restricted to the relatively small quantity of fat of edible grade which is not suitable for use in margarine, principally because its taste is not bland enough.¹ Thus the production of oleo fats is about five times as large as that of edible tallow. In the large plants, such edible tallow is rendered from some of the cutting scrap fats, from cattle condemned for a slight infection of such diseases as tuberculosis or measles,² from sausage scrap, rennets, gullet ends, and similar materials. Sometimes the scrap from the oleo kettles, or oleo bottoms, is used. Edible tallow is also extracted from bones and from glue stock. In plants which are not large enough to operate an oleo department all edible fats, including caul and ruffle fats, go to edible tallow. Finally, in establishments not under federal inspection such materials are

¹ In some sections "edible tallow" is the term given to the edible beef fat produced by non-federally inspected plants. It is superior to the run of inedible tallow, but may be used for food purposes only within intrastate trade. Probably the great bulk of it goes to industrial use.

² *Readings in Packing-House Practice* (prepared and edited by the Committee on Packing-House Practice and Practical Research, Institute of American Meat Packers, Chicago, 1926), Part I, p. 142.

largely forced to inedible tallow, or are used to adulterate lard.

TANKAGE AND CRACKLINGS

The cooked meat, bone, and sinew remaining after the expression of fat is known as tankage or digester tankage when the wet or digester process has been used, and as cracklings when the process is either the old open-kettle rendering method or the modern one of dry or vapor rendering. These products, when dried and ground, furnish finely divided meals of brown color and distinctive odor. Tankage is always inedible, while cracklings are edible or inedible according to the nature or origin of the raw material. The residues from steam lard, wet-rendered greases, and the by-product of wet-rendered tallow (edible or inedible) are all designated as tankage. On the other hand, the scrap or by-product from kettle-rendered lard and dry-rendered tallows and greases is known as crackling. Lard cracklings or flour are edible, being used in such products as sausage and scrapple.¹ Cracklings are lighter in color, higher in protein content, and higher in price. Besides the outlets available to digester tankage, as ingredients in fertilizer mixture and stock feeds (mainly hog feed), they are also used in poultry feeds and in foods, such as dog biscuits, for animal pets. Feeding or digester tankage contains 40 to 60 per cent of protein. Both contain considerable phosphoric acid, depending upon the amount of bone in the material processed. A much inferior and lower-priced grade, known as garbage tankage, is produced by municipal reduction works and sold for use as a fertilizer base.²

¹ Edible cracklings are obtained from selected raw fats, containing practically no bone; whereas tankage from prime steam lard and the like contains a considerable proportion of bone.

² The term "tankage" is loosely used in the trade. In its more specific meaning, it connotes the residue from the wet-rendering system, as noted above. It is sometimes also applied to the raw material to be rendered—the material that goes to the "tankhouse" and rendering tanks. The residue from

Tankage and cracklings are mainly sold to compounders. The large packers and a few large renderers, however, utilize their own output in the manufacture of feed and fertilizer, directly or through subsidiaries. A relatively small proportion is sold directly to such farmers or farm co-operative associations as prefer to prepare the requisite mixtures. When sold for feed, tankage and cracklings are quoted upon the basis of protein content. The usual price is about one dollar per unit of protein, or about 50 to 65 dollars per ton. When sold for fertilizer the price is based upon ammonia content. Ammonia and protein content are equivalent terms, the percentage of protein being slightly more than five times the units of ammonia present in the material. Ammonia is the most expensive plant food in commercial fertilizer; and protein, likewise, is the most costly element in mixed feed.

Containing from 40 to 70 per cent of protein and 7 to 12 per cent of fat, tankage and cracklings are obviously rich feeds, to be supplemented by coarser materials and fillers. The feed trade demands a minimum fat content of 5 per cent, desired to maintain poultry or other animals in good condition. A fat content in excess of 12 per cent is considered to be detrimental. Since fat is higher priced, only the minimum percentage is left in the residual material. A high percentage of fat is also detrimental in a fertilizer since it inhibits rapid decomposition in the soil. In mixed feeds, and especially for poultry feed, tankage and cracklings are mixed with ground raw bone to supply bone phosphate, and with coarse materials and fillers such as ground alfalfa. A representative mixed feed would consist of 20 per cent of tankage or cracklings, 20 per cent of raw bone, and 60 per cent of coarser material, largely carbohydrate and roughage.

These products have become important factors in the feed and fertilizer trades. They are basic in most of the commercial stock feeds now so extensively used in the

other industries is also designated as tankage. Thus the hide-and-bone residue after the extraction of glue and gelatin is tankage, used as a fertilizer base. Waste materials such as fur, felt, leather scraps, and so forth, are sold under various brands or names, e.g., "nitrogenous tankage."

feeding industries, and the bulk of the product is now so used. They constitute also an important fertilizer, although their use for this purpose has relatively declined, partly because of the feeding demand and also because of the increasing use of mineral fertilizers. In some soils, however, mineral fertilizer is regarded as being less efficient than animal fertilizers, a point with the correctness of which we are not here concerned.

CHAPTER IV

SOURCES OF TALLOW AND GREASE, AND METHODS OF RENDERING

The commercially available animal by-products and wastes, the sources from which tallow and grease are produced, come from a number of heterogeneous sources. Roughly, they fall into six classes: (1) slaughterhouse by-products, including animals dying en route to slaughter or condemned at slaughter; (2) shop fats, suet, trimmings, and meat wastes from retail butchers, meat markets, and grocers; (3) similar wastes, with used or spent fats, from hotels and restaurants; (4) household garbage; (5) fallen animals; (6) miscellaneous animal matter. Shop fats are an important source of tallow; slaughterhouse by-products yield large quantities of grease and tallow; condemned or dead animals are sources of tallow or grease according to the type of animal; and the remaining three classes yield chiefly grease, most of it being produced in plants located near the more densely populated sections.

SLAUGHTERHOUSE MATERIALS

Of these materials, slaughterhouse by-products are the present source of more than half the total output of inedible fat.¹ The primary product of the slaughtering industry is dressed and cured meat. The word "offal" was formerly used to cover both edible and inedible products of slaughter that were not properly classified as major

¹ Slaughterers produce slightly less than half of the total grease and tallow, and the great bulk of their raw material consists of offals that arise within the plant. In addition, a considerable proportion of the renderers' raw material consists of such offals, purchased from small slaughterers.

products. For obvious and justifiable reasons the American trade prefers to apply it to inedible products. Parts such as kidney, heart, liver, and sweetbreads, formerly classed as edible offal, are now termed "fancy meats" or "miscellaneous meats." It is of course the aim of the slaughterer to utilize the maximum amount of his raw material in higher-priced meat foods. For trimmings and for edible offals not sold as fancy meats there are a variety of food outlets—canned products such as soups, extract of beef, bouillon cubes, chile con carne, as well as sausage, scrapple, mince meat, and so forth. Surplus fat that cannot be marketed with carcass and miscellaneous meats are rendered for different grades of rendered fat.¹ Visceral and trimmed-off body fats are suitable for edible fats of oleo grade, such as neutral lard and oleo stock, but under certain conditions, to be described later, yield inedible fat. A considerable amount of edible fat is extracted from bones before these are sold for commercial bone or processed for glue, gelatin, and fertilizer.

For the relatively low-priced inedible fat, modern packing-house practice leaves only the materials unfit for food use. This includes guts, pecks, paunches, windpipes, ends of the mid-intestines and gullets, condemned meats, spoiled and contaminated materials, and a large variety of trimmings and scrap, catch-basin and floor accumulations. According to information kindly furnished by one of the great packing concerns, the average yield of inedible tallow and grease from sound animals, in pounds per head, is as follows:

	Inedible tallow	Animal grease
Cattle	6.9	.4
Calves	1.5	.2
Sheep .....	.4	.1
Hogs .....	...	3.3

¹ See also "Distribution of Fats in the Animal Carcass," Appendix, p. 307.

The yield is doubtless larger in small establishments, which do not possess the requisite volume, equipment, and large market for the preparation of specialized food products.

Condemnations, either of entire animals or carcasses, or of viscera and primal parts, and animals that arrive dead or in a dying condition are important additional sources of packers' inedible fat. There are, also, other sources. Meats sometimes become rancid or sour, in the course of distribution, and about 9 million pounds of such meats are annually condemned upon reinspection. It sometimes happens that considerable quantities of dry salt meats, and even lard that has been held too long because of a poor market, become rancid and go to inedible fat. So also does fat that is so intimately a part of meat and bone that it is not practicable to separate it for lard, oleo, or edible tallow. Finally, as we have seen, in the establishments which do not operate under federal inspection, millions of pounds of by-products that would ordinarily go to food uses, or to edible fats, are rendered for inedible fat.

WASTES OF MEAT MARKETS AND BUTCHER SHOPS

The second class of material, the wastes collected from meat markets, butchers, and grocers, is similar to that obtained in the cutting and boning department of the large packers. It consists of suet, shop fats, and bones. The suet is about 80 per cent pure fat, being beef suet, kidney and cod fat, and so forth, such as in the packing plants would go to make the highest grade of oleo. Shop fats consist of the various trimmings from the cuts of meat. The bones have had the meat largely trimmed away.

In such materials beef and mutton fats predominate over hog fat because of the different practices customary in dressing the carcasses of these animals. It is a trade custom to ship the carcasses of cattle in sides or quarters,

while calves, sheep, and lambs are usually shipped in whole carcasses. It is customary to leave a considerable quantity of the best fat, for example, much of the kidney and pelvic fat, attached. Indeed, the carcasses or sides of cattle, calves, and sheep are shipped with the maximum content of fat adhering to them, and the kidneys are marketed as a part of the carcass. In the case of sheep, the fats of which are especially high in titre, most of the fat is left on the carcass, the caul being removed for oleo, and the "black guts" being tanked for inedible tallow.¹ Hog carcasses, on the contrary, are as a rule divided into cuts prior to delivery to the retailer, and most of the fat has been trimmed off. Much of the product, to be sure, is in itself very fat, but it is sold to the ultimate consumer by the retailer without much further trimming. This is the case even with most cured and salt-pork products, though not to the same extent as with fresh pork. Some hogs are shipped as whole carcasses with much of the fat left adhering to them; this is especially true of the small and non-federally inspected slaughterhouses, which do less curing or processing, and market chiefly fresh pork. All in all, however, hogs contribute a relatively small quota to the supply of shop fats; hog trimmings and wastage are contributed chiefly by the ultimate consumer and find their way into garbage rather than into shop fats.

The excess of beef and mutton fat that is usually trimmed off in the butcher shop or in the public eating-place is either sold to renderers, utilized in chopped meats and homemade shortenings, or consigned to garbage, fed to animals, or discarded. In purchasing a "side" of beef of good grade the retailer receives from 55 to 65 per cent of lean meat, from 20 to 30 per cent of visible fat, and from 10 to 15 per cent of bone.² Usually butchers,

¹ *Readings in Packing-House Practice* (prepared and edited by the Committee on Packing-House Practice and Practical Research, Institute of American Meat Packers, Chicago, 1926), Part II, p. 67.

² H. C. Marshall, *Retail Marketing of Meats*, p. 2.

grocers, and others dealing in meats at retail throw fats of excellent quality into the same scrap box with trimmings and waste or spoiled meats. Moreover, often the fats remain in the scrap box for days without refrigeration before they reach the rendering tank. In that event they yield a fat of a higher free fatty-acid content and inferior quality. In some localities the kidney, pelvic, and other fats of better grade are segregated and promptly collected, yielding a fat of high melting point and good quality.

Slaughterers apparently believe it more profitable to sell fat at the price of carcass meat than to trim off this fat in the packing house for the production of comparatively low-priced fat.¹ It may be questioned whether this reasoning is sound. It is probable that in the long run competition forces a discount on the price of meat corresponding to the loss of the retail butcher and ultimate consumer on the fat for which they pay meat prices. The advantage to the packer may be wholly illusory. Abandonment of this trade practice, however, is rendered difficult by established local customs and the competitive character of the industry. It is reported, however, that there is a growing tendency among packers to divide the carcass into cuts and thus to trim away the by-products.

At any rate, the practice involves a serious economic waste. A large amount of the best grade of fat is sent to retailers and consumers who have relatively little use for it. Some of the loose and semi-loose fat is lost in transit, falling to floor or pavement while loading or shipping is in progress.² Most of such fats are trimmed off by

¹ "Skirts and fats, etc., should be left on the inside of the carcass, as fat commands but a low price if removed from the carcass, yet brings a carcass beef price if left on the carcass"—*Readings in Packing-House Practice*, Part II, p. 25.

² *Extent and Growth of Power of the Five Packers in Meat and Other Industries* (Report of the Federal Trade Commission on the Meat-Packing Industry, Part 1), June 24, 1919, p. 372.

the retail butcher. By the time the portion of the fat that is salvaged reaches the rendering tank, a great deal of it has deteriorated in quality so as to be no longer fit for edible purposes. It is noteworthy that formerly sheep were dressed in nearly twenty different ways, but that during the World War a uniform "dress" was established to conserve food. Sheep were then so dressed as to remove the caul fat in order to save it for edible purposes instead of permitting it to find its way to the butcher's scrap box. This standardized dress of sheep was found to be so advantageous that it has since been retained, with some minor variations.

Not all the trimmings and shop fats of the retailer go to the meat scrap box for sale to renderers at 1 to 5 cents per pound. The larger and more efficient retailers are able to obtain higher prices by incorporating part into edible products; in ground meats such as sausage, hamburger, and meat loaf, in pot and rib roasts, and in homemade shortenings. If the raw material is kept under refrigeration, this does not appear to be objectionable. Such outlets, however, appear to be limited. Only the leaner trimmings, as a rule, may be used in sausage and similar products, since an excess of fat results in an undesirable product. And it appears to be the opinion of the trade that the production of "homemade" shortenings has fallen off owing to the competition of vegetable compound and high labor costs. It is simpler to sell fats to renderers, where such a market is available. Some of the larger provisioners also render surplus wastes by the open-kettle process, usually selling to renderers the resulting partially degreased cracklings. The relative price of meats and fats is an influence in determining how much waste is to be sold to renderers. If meat prices are high, the retailer makes more of an effort to "work off" wastes in the form of edible products. The average large city contains hundreds of retail and wholesale distributors

of meats. The wastes from such establishments yield tallow of fairly good quality. Renderers frequently blend such materials with slaughterhouse offals, purchased from small plants, and thereby improve the quality of the derived product.

In Chicago and New York much "butchers' offal," as well as junk bones and dead animals, is gathered by collectors or scavengers, and there is sufficient market to admit of regular quotations. Since prices appear to fluctuate only slightly, some idea of current values may be gained from the following sample quotations, given in cents per pound:¹

	At Chicago	At New York
Suet	5½-6	6
Condemned suet .....	...	5½
Shop fat	3	2¾
Breast fat .....	...	4½
Bones	½	...

HOUSEHOLD AND RESTAURANT WASTES

Garbage grease, a product of very low quality, is produced in municipal reduction plants from kitchen waste consisting of animal, fish, and vegetable materials. It is essentially a municipal project, distinct in its problems. Of municipal reduction more will be said in a later chapter dealing with this subject.

The fat rendered from hotel and restaurant waste is known as house grease. On the price scale it ranks third among the major grades upon which quotations are regularly made, the order being white, yellow, house, brown, naphtha, and garbage grease. Like garbage grease, it is a mixture of different fats, brown or dark colored, but the free fatty-acid content is relatively low. Much of the raw material, though heterogeneous in character, is high in fat content. To secure meats of the type and quality desired by its patrons, a hotel or restaurant generally

¹ Taken from *The National Provisioner*, June 30, 1928, LXXVIII, 50, 56.

finds it preferable to purchase supplies in the comparatively expensive form of specific cuts, instead of in quarters, sides, or carcasses. These cuts are selected from the stocks displayed by wholesale distributors, who of course buy the larger units from the packers. Lamb and beef cuts in particular contain an excess of fat and bone, bought at the price of carcass meat, that cannot be served and must be trimmed away. Such trimmings, bones, and excess fat are cooked for soup stock. Many houses, in fact, buy additional bone for this purpose. Excess fats or trimmings that cannot be utilized in this way, and some of the unconsumed cooked meats served to the patrons, are tried out or rendered for a homemade shortening. This is utilized in preparing certain classes of food which require much grease (especially "French fried" potatoes), reducing somewhat the substantial expense for commercial shortening incurred by the average restaurant.

It follows that the material derived from hotels and restaurants mainly comprises used or spent shortenings, greases, and cooking fats, and wastes from the preparation and consumption of food. The last class of waste is composed of a wide range of animal matter, from fowls, fish, and meat animals, and also of much material of vegetable origin. In some sections the large establishments sell to the renderers only the used greases and shortenings, contracting with hog feeders for the larger accumulations of other waste or swill. Renderers also obtain the grease from the "interceptors" or grease traps, of which an increasing number are being installed in the kitchens of the larger hotels and restaurants. These are similar in operation to the catch basins of the meat-packing plants, whereby waste waters or sewage are run through a series of baffles which trap greases and solid matter.¹ In the kitchens the purpose of these interceptors

¹ It is interesting to note that both in Europe and the United States experiments were made during the World War with the view of recovering grease from city sewers. It will be recalled that during this period there was an acute

is not so much to salvage grease as it is to reduce costly plumbing repair of clogged pipes and sewers. These kitchen appliances are usually installed and maintained by equipment manufacturers upon a rental or royalty basis. Municipal ordinances designed to prevent the fouling of streams and clogging of sewers occasionally necessitate the use of equipment of this kind, especially in the packing plants. Such ordinances, together with the inconvenience and expense arising from flooded sewers, were in fact initially responsible for the development of catch-basin equipment.

FALLEN ANIMALS

The fifth type of material listed above includes fallen horses, cattle, dogs, and other animals. One part of the supply has materially declined, while another part has been increasing. Chiefly because of the great decline in the number of horses in cities, the supply of such stock available in or near the cities is now much less important than it was formerly.¹ While the supply of city animals has fallen off, increasing numbers of animals that have died on farms are being rendered. This supply is to some extent seasonal, depending upon the condition of the roads. There are renderers who send motor trucks quite

shortage of fats. "A comparatively small plant for the recovery of sewage grease has been in operation for some time on one of Boston's outfall sewers. As a result of these experiments, Dr. Sedgwick, of the Massachusetts Institute of Technology, who has been in charge of the plant, states that 25,780,000 tons of recoverable grease go to waste each year in the sewage of 97 American cities. Average sewage contains about 430 gallons of recoverable grease in each million gallons." From *Production and Conservation of Fats and Oils in the United States*, U.S. Dept. of Agriculture Bulletin 769 (February 1919), p. 41.

¹ In 1910 there were 24 million horses and mules on farms and in 1928, 20 million. The number of horses in cities, which furnish most of the dead horses to renderers, decreased more rapidly. In 1910 it was 3,453,000 and in 1920, 2,084,000. As the duration of life of horses in cities is short, the number of dead horses available to renderers each year must by no means be negligible. In 1927 the city of Chicago collected and disposed of 61,637 dead animals as follows: horses, 1,949; dogs, 41,915; cats, 9,980. In 1926 the number of horses was 2,201.

long distances into the country to collect this sort of material.

Cities usually contract with renderers for the collection and disposition of dead animals. A considerable quantity of horse oil (considered to be superior to any other fat for mixing with petroleum products in lubricating compounds) was formerly derived from this source. Western renderers sometimes render large numbers of wild horses, rounded up on the range and shipped several hundred miles to such plants. Ordinarily horses are either consigned to the grease tank, or if sufficient packing-house offal and butchers' waste of higher titre are available they are cut up, the visceral portions used in the grease tank, and the balance rendered with such tallow material. Other animals, excepting cattle which go to tallow, are rendered for grease.

MISCELLANEOUS ANIMAL MATTER

Certain other sources of grease and tallow, though of less importance individually, deserve passing mention. Many packers cook bones for the removal of part of the fat before sale to glue manufacturers and others. Such bones produce "extracted bone glue," yielding an additional 4 or 5 per cent of bone grease obtained by percolating a solvent (benzin) through the crushed bone. Grease is also obtained as a by-product in the manufacture of glue and gelatin from trimmings of hides and of calf, sheep, goat, and rabbit skins. Some of these materials for hide glue, notably fleshings and splits, yield a considerable by-product of grease, recovered in cooking the hide stock.¹ A small quantity is also obtained by treating the residue or tankage, after hide glue has been extracted, with a volatile solvent. Glue stock supplied by

¹ Fleshings are the scrapings of the loose connective tissue and fatty matter from the flesh side of the hide or pelt. Splits are likewise trimmings from the flesh side, but include part of the trimmed hide as well.

the packers consists of a variety of bones (head bones, feet, knuckles, as well as green and packer bone), and of sinews, lips, ear drums, mammary glands, and so forth. Trimmings, fleshings, and the like come from the tanneries; and a variety of used leather is also utilized. Junk bones are also picked up from every available source; and much glue stock, as well as glue and gelatin, is supplied by imports.

There are a number of other sources of inedible animal fat. Hog-serum plants produce considerable grease. From tankage of various descriptions appreciable quantities of grease are obtained and separately reported in the census. Packers and large renderers often buy partially degreased tankage from the small or inefficient plants, for further extraction. Some plants, reported to be short-lived, specialize in this business, the degreasing being accomplished by the application of naphtha. Grease is also extracted from fur trimmings and scrapings, from fowl entrails and spoiled fowls, obtained from poultry-packing establishments, distributors, and others, and from a similar by-product of rabbit-dressing plants. A plant in New Mexico is engaged in rendering burros, and, as previously stated, a considerable number of wild horses go to the rendering plants. In short, the raw material comprises nearly any fat-containing animal matter that is available in sufficient quantity to justify collection and processing. However low the fat content, the material swells the volume of tankage, for which there is a ready market in the feed and fertilizer industries.¹ The ammonia content of the tankage is increased by the addition of dried blood and "stick," both of which are frequently bought by renderers, and of hoofs (see p. 84).

¹ The more efficient plants, however, run animal matter containing no fat directly into the tankage dryer. If "tanked" or rendered with other materials, the non-fat-containing matter will absorb rendered fat to the extent of 7 to 10 per cent of its weight, and it is not commercially practicable to extract this residue. Since tankage is sold almost entirely upon its ammonia or protein content, there is no return for such fat. However, under normal operating conditions there is always a residue of fat in tankage which it does not pay to extract.

In addition to the foregoing, there are several minor waste greases, difficult to classify. Some recovered grease or "degras" is obtained from tanneries and textile mills; this may be in part of vegetable origin. In producing chamois leather as much whale, menhaden, or other marine oil is worked in as the leather will absorb. The excess fat, subsequently removed, is known as "moellon," "sod oil," or "degras," according to the process of extraction.

In a few places spoiled or surplus fish and trimmings are collected and rendered. The oil is of low grade but the residual fish meal is a valuable poultry feed and commands a relatively high price. It is probable that this form of salvage will be considerably expanded. The oils of fish and marine animals, some of them used for food, are regarded as a separate group. So also is wool grease (lanolin), a small amount of which is produced in the scouring of wool. It serves some of the uses of fat in industry, especially in pharmacy, but it is not, chemically speaking, a true fat and has no food value. None of these materials is considered in the present study.

YIELD OF RENDERED FAT

Different materials vary widely in fat content; and the yield varies, also, with the method of extraction. If obtained from packing-house by-products, yields vary with the weight and condition of the animal, the cutting and operating methods, the relative price of fat cuts and meat (in the case of hogs), and the percentage of condemnations. Leaf fats, open-kettle rendered, yield about 91 per cent of lard, depending upon the "finish" of the animal and the care exercised to avoid contamination. From that figure yields go down to a few per cent as in the case of well-trimmed stomachs. Bones yield from 10 to 16 per cent. Raw oleo fats produce from 60 to 72 per cent of oleo stock.¹ Caul fats from calves yield about 52 per cent, from sheep 80 per cent, while beef-cutting suet (kidney

¹ *Readings in Packing-House Practice*, Part I, p. 135; Part II, p. 106.

suet) and beef-cutting fats yield 75 to 80 per cent, according to the degree to which they are composed of fatty tissue or of meat, bone, and scrap. The yield of fat from condemned, dead, or fallen animals is fairly high, though varying, of course, with the kind of animal and its condition. Hogs yield as much as 50 per cent of fat, cattle from 8 to 20 per cent, and horses only 3 to 9 per cent. Based upon a considerable number of tests made by a manufacturer of rendering equipment, the yield of inedible tallow (packers) from the average run of material consigned to the tank room is about 18 per cent, while the yield of cracklings is 26, moisture being 56 per cent. Of packers' grease, the yields vary widely, owing to a range of moisture content of from 40 to 70 per cent, depending upon the number of condemned hogs. Moisture is an important consideration; it not only affects quality, but also increases costs, especially if the kettle-rendering or dry-rendering process is used, in which case the water must be evaporated at the expense of fuel.

Of all materials garbage is the poorest in fat; it varies greatly, but as it comes to the municipal reduction plant it averages only about 2½ to 3 per cent of grease. It also contains the most moisture. Moisture in shop fats is from 35 to 40 per cent, in dead stock 50 to 65 per cent, and in garbage about 75 per cent.

In Appendix A will be found a number of analyses and tests showing the yields of tallow, grease, and cracklings from different kinds of animal by-products and dead stock. These analyses give yields from the dry-reduction process.

METHODS OF PRODUCTION IN GENERAL

The modern and highly specialized methods of producing different classes of animal fats are primarily American in their development; and in the world trade, nomenclature and trade usages alike are dominated by

the American product and processes.¹ These processes have been adapted to the treatment of masses of raw material, of widely varying quality and origin. In fact, the great bulk of the domestic product is contributed by large establishments, mainly of the meat packers and renderers. Excepting a few great plants in South America and Australasia, the foreign product is characteristically the output of innumerable small units, by methods better adapted to the needs of small units. In vegetable oils the situation is in most respects distinctly different. Europe has largely developed the modern methods of crushing and refining, and her production, chiefly from imported raw materials, is upon a scale comparable to that of the United States.

Differences such as these, in the distribution and magnitude of the manufacturing industries, are in part to be ascribed to variations in the volume and concentration of available raw material. In considerable part, however, they are the result of characteristic differences between the animal and the vegetable raw material. Raw animal fats must be treated at the point of origin, while oilseeds and nuts, chiefly grown in tropical and subtropical regions, enter into an extensive international trade. It follows that in animal fats the production of raw materials and subsequent processing tend toward national integration. In most vegetable oils, on the other hand, the growing of raw materials, the extraction of oil, and refining are widely separated.

Another difference in the animal and vegetable product is of significance in the present connection. Raw animal fats deteriorate rapidly; it is essential that such material be speedily processed and guarded from contamination. Furthermore, in the United States no animal

¹ Thus in Liverpool, the principal British trading center for lard, only American brands were tenderable "in the pit" until 1925, when one Canadian brand was established. Offerings from Canadian and other sources are still relatively unimportant.

fat classed as inedible may be refined for food use—that is, in the interstate plants; and the refining of edible fat is likewise prohibited in such plants, except that the color of steam lard may be improved by treatment with bleaching earths.¹ In consequence, the condition of the raw material and the process to which it is initially put jointly determine the trade classification and use of rendered animal fat. The refining of vegetable oils, on the other hand, is an important industry. Relative costs and returns constitute virtually the sole limitation upon the extent to which a crude vegetable oil is refined or improved in quality. It will shortly be seen, moreover, that the trade designations of different edible animal fats connote particular processes or classes of raw material, or both, with which a distinctive product is associated. These designations, established in trade usage, are continued and protected by meat-inspection regulations which forbid misbranding or adulteration. Such restrictions are manifestly in the public interest. Yet they present an interesting contrast. If, for example, through an advance in the technology of the industry it becomes possible to produce an identical product by a different process, or from a broader class of material, the regulations would prohibit such a change, unless the product be differently labeled. The producer then faces the difficult and costly task of altering established trade conditions—substantially of creating a demand for a new product. In vegetable oils, producers enjoy a much wider latitude, for here emphasis is placed upon the character of product rather than the process. For such reasons, particular importance attaches to the conditions under which animal fats are produced.

The three distinctive methods employed in the pro-

¹ This general statement does not apply to the fats derived from milk. Sour cream or butterfat, and rancid or decomposed butter are, of course, refined or renovated and used as food or in food products. Likewise, cheese may be reprocessed or refined. (See also pp. 273-76.)

duction or extraction of animal and vegetable fats and oils are commonly termed rendering, expression, and solvent extraction. In American practice only a small percentage of the total product is obtained by the last method—that of extraction by means of volatile solvents; yet the total volume of inedible fat so derived is not inconsiderable. The great bulk of the animal fat, however, is obtained by rendering, and of the vegetable oils by expression (grinding and pressing). American practice, therefore, largely employs “physical” methods, entailing the application of steam, presses, and the like, as distinct from “chemical” methods, involving the use of solvents or chemicals. It is probable that sanitary regulations have contributed to this end, though historically the application of solvents was of later development.

Rendering, strictly speaking, is the term applied to the trying out of animal fats, whether edible or inedible; that is, to the separation, by means of heat, of fat from tissue and cellular structure. In the trade a further distinction is sometimes made, extraction at high temperatures being called “rendering,” and extraction at low temperatures, “melting.” Steam or pressure rendering admits of a more complete and easy separation of fat, but the product has a “high” cooked flavor and odor characteristic of the fat used. This may be an advantage or disadvantage, according to the requirements of different markets. Melting, supplemented by a preliminary chilling of the raw fat, yields a product of a neutral or “buttery” flavor, e.g., neutral lard and oleo, utilized in oleomargarine, baked goods, confectionery, and in other uses where the lard or tallow flavor would be objectionable. Such neutral fat does not keep as well as the more thoroughly cooked product, extraction is relatively incomplete, and ordinarily the melting process is applied only to materials high in fat content, and of the best quality, such as leaf, caul, and back fats. Neutral lard is “melted” at a tem-

perature of about 126° F. (52:2 C.); oleo stock at 155° F. (68:3 C.); steam lard and wet-rendered tallow and grease are rendered in digesters at a pressure of about 40 pounds (temperature of 286:9 F. [141:6 C.]).

The successive advances in the methods of rendering have been essentially engineering developments—amplifications of or improvements in the requisite machinery, originated by mechanics and engineers within the plants and by concerns specializing in the manufacture of packing-house equipment. However, chemical analysis of the products in the several stages of advancement affords a means of gauging the efficiency of operators and equipment—it furnishes a control. Although many plants do not employ chemists, commercial fats and tankage are usually sold on chemical analysis, and such analyses afford a constant check.

OPEN-KETTLE RENDERING

Until a comparatively recent period the method of rendering animal fats seems to have been substantially the one employed since the beginning of recorded history. The fatty materials, with or without added water, were cooked in iron kettles over a free fire, causing the bursting of the fat-containing cells. Usually the separated fat was remelted and strained for clarification. The details of the process, as well as the character of the product, varied with the individual operator. The method, however, is comparatively wasteful of fuel and product. Moreover, the product, a dark-colored fat of variable quality, was subject to scorching or complete destruction, and the process was attended by disagreeable odors. The lard so produced, mainly from leaf fats, was the original "kettle-rendered lard." Although dark in color, slightly scorched, and coarse in texture, it had the distinctive flavor and odor of fried fat or crackling, preferred by many consumers.

This early method of rendering is by no means extinct. In Europe it is reported to be in extensive use among small

producers. In the United States this is the method employed by many hotels and restaurants in preparing a grease from meat wastes for their own use. It is used by small slaughterers, butchers, meat markets, and sausage kitchens in melting by-product or meat scrap, producing "butchers' lard" and tallow or grease; and also by farmers in producing "country lard" from leaf and back fats of farm-killed hogs.¹ Likewise, many packers produce bone tallow and grease, and neatsfoot oil, by slowly cooking bones (with added water) in open vats and skimming off the fat.

Next in commercial application came the system of rendering in open kettles, jacketed on the sides and bottom. Steam is turned directly into the jackets for kettle-rendered lard, and water (usually heated from an exhaust line) for neutral lard and oleo. The raw fat, first hashed into small pieces to facilitate extraction, is cooked in its own moisture, at temperatures varying with the different classes of product. Salt is generally added to assist separation of the fat, and the material is continuously stirred or agitated to insure uniform and thorough cooking. When the material is tried out and the moisture driven off, the fat is drained, and then strained in different ways. The residual material—lard cracklings or greaves, and oleo scrap or bottoms—contains a considerable percentage of fat. Lard cracklings, which contain from 15 to 35 per cent, are run through a press to recover some of the contained lard, the final cracklings containing 6 to 12 per cent of fat. Sometimes cracklings are added to material for steam lard. Oleo bottoms are remelted with the next batch or rendered for tallow.

Compared with the older method, the use of jacketed kettles conserves fuel, admits of a more uniform and controlled application of heat, and probably increases yields. In details, there are some variations in the practice of different plants. In essentials, however, plant practice is uni-

¹ A grade of butchers' lard is also produced by meat-packing plants. It is made by adding cracklings from kettle-rendered lard to steam lard and thereby obtaining the flavor and darker color characteristic of the former. This product goes to a trade that will not pay the higher price of packers' kettle-rendered lard. Under federal regulations, also, meat packers may produce a "country-style" lard (not "country lard"), if such lard is rendered in open kettles.

form; and although a number of refinements have been introduced, the fundamentals have changed little. The early square or round kettles have been replaced by cylindrical tanks, and the manual operations of cutting up and stirring the fat have given way to power hashers and mechanical agitators.

Accordingly, variations of this method of rendering in jacketed (open) kettles are used to prepare oleo, neutral lard, and kettle-rendered lard. Beef and mutton fats, when rendered for edible commercial fat, mainly go to oleo. Of the edible tallow, a portion is kettle rendered, at higher temperatures; but the bulk of it is wet rendered, in the manner described below. Many packers produce a kettle-rendered lard as their top or "fanciest" grade, made from the best class of materials; but a number of plants now put all edible hog fats into this product, the less easily rendered materials being first ground to assist extraction. It should be noted, furthermore, that the new method of dry rendering is in reality a further development of this process.

WET OR STEAM RENDERING

Open-kettle rendering is not well adapted to mass production, nor to the treatment of materials low in fat content. Extraction of fat is relatively incomplete; the product is dark in color and its quality easily impaired. Lard so prepared, however, is often regarded as being superior to any other fat for cooking purposes. From the manufacturing viewpoint, the wet or pressure system is a more efficient and economical one. It is a system whereby the fatty materials are thoroughly disintegrated by the direct application of steam, under pressure, whereas in the kettle-rendering process, it will be recalled, the fatty material is cooked in its own moisture. According to the estimates of the trade, "steam lard" produced by the "wet" method now constitutes about 80 per cent of the lard produced. Likewise, the bulk of the tallow and grease is still produced by this wet-rendering process, despite the expansion in dry rendering; so also is most of the edible tallow. We shall briefly describe the application of the pressure system to inedible fats. In its essentials the

system is the same for the edible product, except that lard goes through an additional process known as refining.¹

The wet-rendering system is often termed the digester method. It is also known as steam or pressure rendering. Digesters are upright steel tanks, cylindrical in shape, that can be hermetically sealed. The bottom is a cone, provided with an outlet for drawing off the tankage and tankwater into a "slush box" beneath. The tanks are provided with a "dished head" manhole for charging the materials, with petcocks on the side for drawing off the fat, with steam inlets, steam regulating valves, and the like. Petcocks are also provided to void the vapors or gases produced within the tank. It is good practice to connect these with a water condenser, and to lead off non-condensable vapors to the boiler (whereby they are made nearly odorless) or to a stack. In fact, plants under federal inspection are required to use such means of eliminating or reducing odors. Heads or other bones are put into the bottom of the tank to prevent packing the material, and the animal matter to be rendered is first hashed and thoroughly cleansed. This preliminary cleansing, especially of guts, pecks, paunches, and the like, is regarded as important, but is sometimes neglected by small producers. The contaminating material discolors the rendered fat, increases the volume of raw product to be handled, and reduces the percentage of protein (ammonia) in the finished product. Since animal matter of low fat content, such as lungs, absorbs a considerable percentage of fat, such matter is usually separated and added to tankage in the driers.

As the raw material is charged into the tank, cold water is kept running through it until the tank is entirely filled. Full steam is then turned on, the pressure regulated to 40 pounds, and the material thoroughly disintegrated or boiled. The duration of this process is from seven to ten hours, ac-

¹ Edible products are here considered only in so far as such consideration is necessary to an adequate perspective and understanding of the situation in inedible fats. The two classes of product, it will have been noted, are closely interrelated. For a more detailed description of the processes of producing fats, the reader is referred to Clemen, *op. cit.*, chapters iv and v; *Readings in Packing-House Practice*, Part I, chapter xiii, and Part II, Section IV, chapter iii; *Packers' Encyclopedia*, pp. 52-58 and 103-14.

ording to the size of the digester and the character of the material. Steam is then turned off, the pressure slowly relieved, salt scattered over the surface of the rendered fat, and the contents allowed to settle for about two hours. The contents of the digester then consist of three layers: the rendered fat, which rises to the top; a second layer consisting of tankwater—the liquor derived from the fat-bearing material plus the added water; and a bottom layer of undissolved meat and bone residue (tankage). The rendered fat is drawn off through a water-separating device into storage tanks or coolers, and finally dumped into tierces or tank cars.

The tankwater carries in solution up to 40 per cent of the nitrogen—commercially, ammonia or protein—in the animal matter treated. Until a comparatively recent period such waters were discharged into the sewers or streams. This entailed, in the aggregate, a large loss of the most expensive element in fertilizers and mixed feeds; and it is almost entirely upon the content of this element that tankage is quoted. Because of the expense of the requisite equipment, and difficulties of treatment, not a few small renderers and packers who utilize the digester method still waste or imperfectly recover such ammonia. Here, as in the other processes described, there is considerable variation in detail, but the essentials can be briefly stated.

After the upper layer of rendered fat has been drawn off, the tankwater and tankage remaining in the digester are dumped into a slush vat, reheated, agitated, the grease and floating matter skimmed off and added to the next batch of material to be rendered. The liquid and undissolved materials are then separately treated. Tankwater is run into storage tanks, "settled" for about two days at a temperature of 175° to 185° F. (79.4 to 85° C.), and again skimmed for fat. When incorporated in tankage, fats have virtually no value. From the storage tanks the tankwater is pumped or drawn into evaporators, and concentrated to a heavy liquor of 22° to 30° Baumé. It is a gluey or sticky liquor, difficult to handle, known as "stick" or concentrated tankwater. To a much smaller extent than formerly was the case, such liquid stick is further concentrated on "stick rolls" or cylinders, yielding

a product known as "dried stick" or "concentrated tankage." It is thus concentrated to about 50 per cent of solid matter, and contains 14 to 15 per cent of ammonia. Usually this dried stick is added to tankage. Brokers report a fair sale of this product, mainly to small renderers who wish to raise the ammonia content of their tankage. According to the trade, most plants have abandoned the use of stick rolls, preferring to mix liquid stick with pressed tankage, as described below. Irrespective of the method, however, in practice there is always some loss of fat and protein in the tankwater.

The residual material in the slush vat (after as much of the tankwater has been drained away as is practicable) is put into powerful presses, and the expressed moisture, after heating and skimming, is added to tankwater in the storage tanks. The pressed tankage, still containing about 45 to 50 per cent of moisture, is often mixed with liquid stick and liquid blood, and run through driers. Condensers, vacuum pumps, or suction fans are utilized to remove offensive odors, which also reduce the value of the product for feeding purposes. Lastly, the product is milled or ground, screened, and bagged. Ordinarily, the final tankage contains about 10 per cent of moisture—a higher percentage causes the product to sour or ferment, entailing a loss of ammonia—and from 7 to 12 per cent of fat. A good deal of tankage, however, contains as much as 20 per cent of fat, and a number of plants find it profitable to buy such tankage and degrease it, using naphtha as a solvent.

The quality of the tankage varies with the condition of the raw material, the percentage of meat and bone, and the method of treatment. If the product contains much bone it will have a considerable content of bone phosphate of lime (B.P.L.), for which only a small allowance is made. Tankage from condemned carcasses, or materials containing much bone, and steam-bone tankage, generally go to fertilizers. The residue from butchers' scraps—an important part of the renderers' raw material—is relatively high in protein. The trade prefers a product with a minimum protein content of about 50 per cent or its equivalent in ammonia. Since the protein content of most pressed tankage is from 30 to 40

per cent, it is customary to add other materials, such as stick, blood, and cracklings.¹ In fertilizer tankage, materials such as horns, hoofs, and hair are also added. These contain considerable ammonia, but their use in feeding mixtures is forbidden in most states.

When sold for feed, the product is known as "digester" tankage. The great bulk of the packers' product is sold under this designation, with a guaranteed protein content of 60 per cent. The major portion of the non-packer product still sells as fertilizer tankage, although a large and growing amount of it goes to mixed feeds.

DRY RENDERING

Last in point of historical development is the dry- or vapor-rendering process. Introduced into the United States in about 1914, it was materially improved in the next few years, and since 1920 has been installed in a large number of plants. This process has exerted a profound influence upon the salvage of animal wastes. To it, in fact, is attributed much of the recent growth of the rendering industry. By eliminating the tankwater problem, largely doing away with offensive odors, and reducing the number of processes, it has—to use the pointed phrase of the trade—nearly "taken the grief" out of the handling of inedible materials. As yet the process is applied chiefly to inedible materials, but the production of edible fats by this system has commenced and seems likely to increase.

Dry rendering is an amplification of the older system of cooking animal matter in open steam-jacketed kettles. Several methods or systems are sold by competing manufacturers of machinery, but in essentials they do not materially differ. One is known as "straight" dry rendering, in which virtually no pressure is built up inside the cooker; another is the "internal-pressure" method, whereby steam pressure is developed from the moisture contained in the materials; and a third is the "pressure-vacuum" method, utilizing both internal pressure and a vacuum period.

¹ Cottonseed and linseed cake and meal are usually quoted on 43 and 34 per cent protein content, respectively.

The "dry-cooker" or "melter" is a horizontal tank, steam jacketed, and cylindrical in shape. It is provided with a many-bladed agitator, with a charging dome at the top, and a discharge door in the bottom. A "hog" is generally used to grind or crush the raw material—the pecks, paunches, guts, and the like being first hashed and thoroughly washed as in the digester process. In the internal-pressure systems the material is disintegrated by a preliminary cooking under pressure, instead of or in addition to this initial grinding. It is the common practice to include with the material to be rendered a considerable percentage of bone, as well as a priming charge of fat. Some plants, utilizing the internal-pressure system, add large bones (mainly jawbones) to keep the inner shell of the melter clean, and the same bones are repeatedly used. In other dry-rendering units a good deal of bone is incorporated with the raw material, the crushed bone (it is stated) giving the material an open texture which greatly facilitates extraction.¹ It is reported that this practice is affecting the market for commercial bone.

As the raw material is charged into the melter, steam is turned into the inner shell or jacket, and the animal matter cooked in its own moisture, usually under a vacuum. Cooking under a vacuum reduces the boiling point, lessens scorching, and facilitates separation of fat. The mechanical agitator keeps the contents in motion, permitting moisture and gases to pass off more easily and aiding the cooking process. Vapor and gases are carried out through an open stack, released into a sewer, or drawn off by fan, blower, or condenser. Cooking is continued until the moisture is evaporated and the fat separated from bone, tissue, sinew, and so forth. Excessive temperatures are detrimental, because the fat darkens or scorches, and becomes contaminated by gluey or mucilaginous materials. In the digester system such materials are drawn off in the tankwater. In the early stages of the dry-rendering system the gluey matter is held in suspen-

¹ Some specialists advise small packers to incorporate available bone in the cracklings, in lieu of the more usual process of cooking bone separately, skimming off fat, and selling the partially degreased bones. Whatever may be the merit of this suggestion, it is reported by the trade that the increased use of bone in dry rendering is raising the price of bone to glue and gelatin plants.

sion in the water or liquor, and remains with the fat and cracklings when the water is driven off in steam. It is to the absorption of such matter in the rendered fat, or to scorching, that the darker color of the product is ascribed. By lowering steam pressure and using a vacuum period, it is asserted, the gluey material remains with the cracklings, and the danger of scorching is reduced.

After the cooking process, the contents of the melter are discharged into a draining pan, the rendered fat drained away, and the cracklings run through one of several types of press (e.g., expeller, hydraulic, centrifugal) to remove most of the contained grease. The final cracklings, containing from 6 to 12 per cent of fat, are milled, screened, and bagged. The rendered fat is either washed with salt water or settled and filtered to remove the fine scrap it usually contains, and is pumped into storage tanks, or into tierces and tank cars. The duration of the process varies with the amount of moisture in the raw material; it is much shorter, however, than wet rendering.

Nearly all purchasers of rendering equipment, whether for replacement or for new plants, are now installing dry-rendering equipment. Much is claimed for the process. It is asserted that it effects economies of time, steam, power, and labor; largely eliminates disagreeable odors; and produces, also, a grease or tallow of low free fatty-acid content. Perhaps the most notable feature of the system, however, is the improvement it effects in the quality of the residual matter or cracklings. Such cracklings are relatively high in protein (approximately 65 to 70 per cent) because no nitrogenous matter is lost in the tankwater, and are a comparatively odorless and fresh meat meal. When this process is used by renderers, the by-product goes almost entirely to high-grade poultry or other feeds, where formerly it sold at the lower price of fertilizer tannage.

There remain, however, several objections or drawbacks to the dry-rendering process. Such are the indefinite control of temperature in some systems, causing the darkening of the fat; the danger of scorching or carbonizing the product; and the formation of gluey or mucilaginous ma-

terials. These objections are being met in varying but increasing degree by the various modifications or systems introduced by competing manufacturers. It is to be expected, moreover, that considerable difference of opinion should obtain concerning cause and effect, and concerning the efficacy and purpose of different phases of the system. It is still comparatively new, the skill of individual operators varies widely, and different claims are made by rival manufacturers.

The application of the dry-rendering process to the production of lard and other edible fats is being hampered for the present by the customs and established practices of the trade. The futures market, for example, is based upon a prime steam-rendered lard produced by the digester method. Dry-rendered lard is darker in color and has somewhat different flavor and characteristics. It resembles kettle-rendered lard. Refining of these fats is restricted by regulations.

SOLVENT EXTRACTION

There are, then, three methods of trying out or rendering fats—in open kettles, digesters, and dry-cookers or melters, respectively known as kettle, wet, and dry rendering. In addition to these physical methods of production, a chemical method is also employed. This method, introduced much later than steam rendering, is that of solvent extraction, extensively used in the European fats and oils industries. It is relatively unimportant in this country. Most of the municipal reduction plants utilize solvents in extracting garbage grease. Solvents are also employed in degreasing the hide, hair, and bone tankage remaining after the extraction of hide and bone glue. Partially degreased tankage or cracklings are also treated by this process.

The principle of the solvent method involves the treatment of the raw materials with some easily volatile liquid that is a good solvent for fat. The solvent saturated with fat is then drained off from the material under treatment into a still in which the solvent is distilled off, leaving the dissolved fat behind in the still. Many different solvents have been used, but naphtha seems now to be the one most favored in the United States. Most of the solvents are inflammable, and

the fire hazard is among the objections to the process. Other objections are that the process is specialized and technical in character, and that the residual tankage is difficult to free completely from the solvent, which is objectionable if the tankage is to be used as feed. It is claimed by certain manufacturers of solvent-extraction machinery, however, that these objections have been successfully overcome, and that this method of extraction is superior to others, at least for certain materials.

CHAPTER V

VOLUME AND TRENDS OF PRODUCTION IN THE TALLOW AND GREASE INDUSTRY

In preceding chapters we have attempted to provide the factual groundwork for a broad appraisal of the salvaging industries, with particular reference to certain outstanding problems of industrial and public policy. We have indicated the sources and magnitude of animal by-product and waste, and briefly described the raw material for fats, the more important classes and grades of these fats, their respective uses, and the processes and plant employed in obtaining them. Some consideration has also been given to the background of trade practice and governmental control. The discussion has centered upon the inedible animal fats, but enough, it is hoped, has been said of joint or closely related products to afford an adequate perspective of the field. We now turn to a consideration of the status of the industries concerned with the production of inedible fats.

The statistics of total production, first to be considered, show a rather irregular upward trend, and obscure the sharply contrasting tendencies in different sources of supply. In certain branches of the salvaging industries, and in certain areas, production has steadily expanded; in others it has fluctuated greatly, or even declined. These contrasts, their significance, and certain underlying influences will in turn be presented in as much detail as the fragmentary data will permit. Apart from their bearing upon the production of inedible fats, these influences present certain economic, regulatory, and sanitary problems that are of serious import to the livestock industries and to the public.

INEDIBLE ANIMAL FATS

VALUE OF ANNUAL OUTPUT

First we may consider briefly the census data on value of output, which are given in Table 3. The figures are not as good as one might wish. In the first place, while the

TABLE 3.—VALUE OF ANNUAL OUTPUT OF ANIMAL GREASES, TALLOW, AND THEIR JOINT PRODUCTS, CENSUS YEARS 1914-27*

(Million dollars)

Industry	1914	1919	1921	1923	1925	1927
<i>Tallow and grease industry^a</i>						
Tallow .....	....	....	....	} 28.3	} 23.1	} 23.2
Grease (soap stock).....	....	....	....
Tankage .....	....	....	....	} 20.3	} 4.1	} 4.8
Other products ^b .....	....	....	....
Total	24.9	67.3	27.2	48.6	51.4	56.8
<i>Other industries, tallow and grease production only</i>						
Slaughtering and meat-packing ^c	16.1 ^d	45.3	16.8	29.4	35.3	29.0
Fertilizer	1.2	2.0	.4	.6	1.4	....
Other industries ^e .....	....	4.5	1.4	2.5	4.3	....
Total .....	....	51.8	18.6	32.5	41.0	....
Grand total .....	....	119.1	45.8	81.1	92.4	....

* Data compiled chiefly from *Census of Manufactures, 1925*, p. 852; for 1927 the data are preliminary and incomplete. Dots (...) indicate that data are not available.

^a Plants whose product of chief value is tallow and grease. See accompanying text comment.

^b Includes poultry feed, fertilizer, oils, hides and skins, bones, and so forth. Cracklings and part of the tankage are doubtless reported under such feeds and fertilizers.

^c Includes edible tallow—probably not more than 15 per cent of the total.

^d The census reports fats under the three classifications of tallow, soap stock, and grease. In 1914 only the first two were reported.

^e Mainly industries classed as "glue and gelatin," and "food preparations not elsewhere classified" (data secured by correspondence with Census Bureau).

data include the value of all products produced by the tallow and grease industry proper (rendering plants and reduction works), for establishments classified with other

industries they cover only the value of tallow and grease produced. In the second place, the classifications are not altogether uniform. The census classifies under "tallow and grease industry" only those plants whose product of chief value is tallow and grease. Changes in the respective values of the various products may thus cause changes in classification. Moreover, in the biennial censuses from 1921 on, plants with outputs of less than \$5,000 are not included; hence the indicated decrease in value between 1919 and 1921 somewhat overstates the actual decrease. In the third place, changes in prices of the products render unsatisfactory, or even misleading, the comparison of values between different years. Thus the great increase between 1914 and 1919 reflects, in great measure, the much higher prices that obtained in the latter year; while the decline between 1919 and 1921 was due primarily to price declines, for the volume of production, as shown by Table 4 (p. 93), actually increased. Finally, the preliminary data available for 1927 are incomplete.

According to the census figures for 1925, the aggregate value of production of grease and tallow was reported as 71.6 million dollars. Including other products of the tallow and grease industry proper, the aggregate reported value of product was 92.4 million dollars. The value of all the various products obtained from animal by-product and waste was certainly much larger. Apart from incomplete covering of establishments, the unreported value of by-products produced with inedible fat by other industries than the rendering industry proper must be large. In the slaughtering and meat-packing industry large numbers of specialized products, to an unknown total, are derived from offals. Furthermore, the production of glue and gelatin (chiefly from bones of cattle, hide trimmings, fish skins and heads, and so forth) is a distinct industry which has shown a steady growth. In 1925 its

output was valued at about 25 million dollars, exclusive of about 4 million produced by meat packers and others. The fertilizer and mixed-feed industries, likewise, process considerable quantities of animal waste, besides buying tankage for fertilizer and feed mixtures.¹ Other commercial products include raw bone, bone meal, and hides recovered from fallen animals. Finally, it is known that the feeding of wastes to hogs, especially around the cities, has greatly increased. It does not seem possible to make even a rough guess of the total value of output, but certainly it must have been, in 1925, well over 100 million dollars. Only for tallow and grease are the data fairly complete.

VOLUME OF PRODUCTION

Somewhat more satisfactory data are available upon the volume and trends of production. It is true that such quantitative data as to the product of the salvaging industries are limited to greases and tallow. Since these are the main products, the statistics afford an indication of the progress of salvage. The record of production is a significant one. In 1912, the first year for which such data are available, the combined production of animal greases and tallow was 358 million pounds. By 1923 it had more than doubled, to 771 million. In the subsequent five years the reported total output remained at approximately this level, although slaughter and meat production fell off materially. It is noteworthy that the ratio of inedible fat to meat production has materially increased. For every 100 pounds of dressed meat (wholesale production) 3.8 pounds of tallow and grease were produced in 1919, and 5.3 pounds in 1927, or an increase of about 40 per cent. If tankage or cracklings be added to inedible fat, the corresponding figures would be about 11 and 15 pounds. Of

¹ Animal fertilizers are not segregated in the census report upon fertilizers, and no report is made for the mixed-feed industry.

course, if a larger proportion of the losses on the farm, and of the wastes of consumption and distribution, were utilized, these figures would be increased, perhaps to a maximum more than three times as large. Present indications suggest that before many years the output of inedible fat will exceed that of cottonseed oil. The data for the respective years are given in Table 4; the rate of growth may be more clearly seen in Chart 1 (p. 94).

TABLE 4.—PRODUCTION OF GREASES AND INEDIBLE TALLOW, 1912, 1914, 1916-28*

(Thousand pounds)

Calendar year	Animal greases ^a	Inedible tallow	Total
1912	155,216	202,946 ^b	358,162 ^b
1914	220,147	227,339 ^b	447,486 ^b
1916	224,172	275,511 ^b	499,683 ^b
1917	210,018	268,825 ^b	478,843 ^b
1918	243,802	304,891 ^b	548,693 ^b
1919	258,156	251,854	510,010
1920	325,678	263,990	589,668
1921	323,337	326,905	650,242
1922	360,025	362,818	722,843
1923	386,818	384,046	770,864
1924	376,497	388,295	764,792
1925	340,637	378,472	719,109
1926	346,684	425,210	771,894
1927	369,083	404,164	773,247
1928	373,579	391,662	765,241

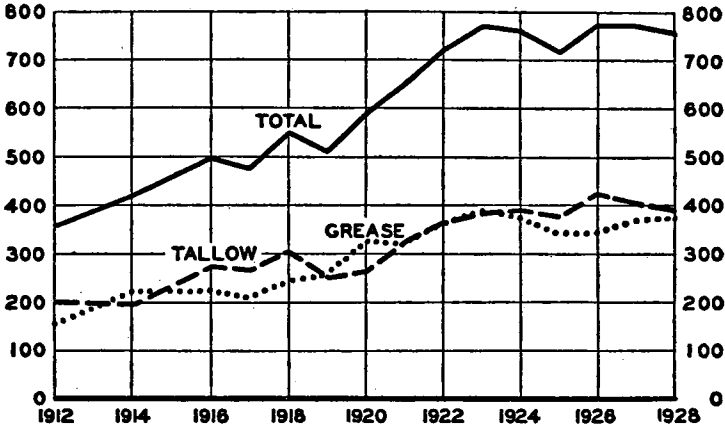
* Data for 1912-18 from H. S. Bailey and B. E. Reuter, "The Production and Conservation of Fats and Oils in the United States," U.S. Dept. of Agriculture, *Supplement to Bulletin 769* (October 1919); for 1919-28, from annual reports of the Bureau of the Census, *Animal and Vegetable Fats and Oils*. Totals computed.

^a For component items in the computed total of "animal greases," see Table 5, p. 101.

^b Figures for inedible tallow, 1912-18, also include edible tallow. On the basis of subsequent data, the edible tallow in these figures may be estimated from 25 to 30 million pounds.

CHART 1.—TRENDS OF PRODUCTION: ANIMAL GREASES AND INEDIBLE TALLOW, 1912-28*

(Million pounds)



* Data from Table 4. None are available for 1913 and 1915. There is a slight difference in comparability between the data for 1912-18 and those for 1919-28.

Price developments (see Appendix Tables I-III) appear to have had little current or direct bearing upon either the rapid expansion up to 1923 or the subsequent fluctuations in output. It is to other influences, of a more fundamental sort, that these changes are to be ascribed. During the war years 1914-18 there was an acute shortage of fats, feeds, and fertilizers, and prices of both fats and tankage reached unprecedented levels. In the next few years prices receded sharply. It was not until 1923 that the price situation showed a material improvement. Yet it will be observed from Table 4 that the growth in production during 1914-18 was less notable than in the succeeding five-year period of price deflation. The 1914 output was about 90 million pounds larger than that of 1912; and in 1918, at the end of four years, there was a further

gain of 101 millions.¹ The largest expansion occurred between 1919 and 1923, a net increase of 261 million pounds in a period of low prices and of depression in other branches of the fats and oils industries. Since 1923 there seems to have been an inverse correlation between the trend of production and prices. Production receded in 1924 and 1925 in the face of advancing prices; again advanced in the next two years of declining prices; the output of 1927 was slightly above that of 1923, at the record figure of over 773 million pounds. The figures for 1928 again show a small decline in output, in a year of rising prices.

Of the causes underlying these swings in production, something is said below. It suffices here to note that the variations from the upward trend of production are mainly the result of fluctuations in the packers' output, which in turn is closely related to the course of meat production. The current price of tallow and grease is made not so much by the interaction of the supply of and demand for these products as by the general market situation in fats and oils, especially cottonseed foots and palm oil. Lard is commonly termed the "barometer" of the fats and oils; its production is huge—around 2½ billion pounds—and changes in its price are transmitted to other fats and oils mainly through cottonseed oil, used in lard substitutes, salad oils, and in the arts. The supply and price of lard are directly influenced by corn prices. When feed is high, meat production tends to recede, a lighter, less fattened class of animals goes to the packing plants, and less of the fat cuts is rendered for fat. Broadly stated, therefore, high feed prices not only make for high prices of tankage and competing concentrated feeds, but also precede a declining production and higher price of

¹ Though 1919 seems to have been a year of low output, actual production was nearly as large as in the preceding year, because the figures for the earlier years included some edible tallow, probably to the extent of 25 or 30 million pounds.

fats.¹ Thus current prices of inedible fat register influences external to the tallow and grease industry; prices tend to be high when meat and fat production decline.

The Bureau of the Census states that "the figures of production do not include those considerable amounts of lard, tallow, and grease produced in the households, on the farms, and by the smaller butcheries and meat markets."² Whether the production of tallow and grease from such sources, especially the "smaller butcheries" or retail slaughterers, has grown, or what its volume is, it is not possible to say. In any event such product would swell the figures cited. In the last few years the reported consumption plus exports of inedible tallow has exceeded the reported supply (production plus imports) by about 100 million pounds per annum (see Appendix Table X, p. 326). Difference in stocks on hand at the beginning and end of a year is relatively small. In the case of grease, if exports be included, there would be indicated a similar but relatively smaller understatement of production (see Appendix Table XII, p. 327). The understatement of tallow and grease production may possibly reach 150 million pounds. So large an understatement, however, seems improbable. It is more likely that the official figures on consumption, which cannot be verified, are less accurate and contain duplications.

Upon the output of by-product feeds and fertilizers (tankage and cracklings), or upon subordinate items such as hides from fallen stock, horse oil, bones, and so forth, there are no data.³ It is difficult to make an estimate, be-

¹ No statistical demonstration of such relationships is here attempted; the results would be inconclusive, owing to the incompleteness of the pertinent statistical data. However, these causes and effects are, in the main, rather generally recognized in the trade, and producers of tallow and grease closely observe the futures markets for cottonseed oil and lard.

² U.S. Bureau of the Census, *Animal and Vegetable Fats and Oils, Calendar Year 1928*, p. 2.

³ A few fragmentary data are available upon the volume of tankage, none for recent years. The *Census of Manufactures* reports the use by the fertilizer

cause the raw materials are of a heterogeneous character, varying greatly in respect to recoverable products, and yields vary with the degree of specialization that prevails within different plants. However, tankage or cracklings is a residual product, the average yield of which, per unit of inedible raw material, is nearly twice that of inedible fat. Its output, obviously, has varied proportionately with the latter. Upon the basis of the ratio of fats to "tankage, feeds, fertilizers" reported by 148 renderers in a special questionnaire (see p. 198), the production of such feeds, obtained as a by-product of inedible fat, was 700,000 short tons in 1927, compared with about 460,000 in 1919 and 320,000 in 1912.

Tankage and cracklings are obtained not alone as the joint product of inedible fat. A similar residue is obtained from the edible fats, lard, the oleos, and edible tallow. Excluding farm lard, the output of the three is about 2 billion pounds, of which $1\frac{1}{2}$ billion is lard. Elsewhere it has been indicated that the yield of lard varies with different materials; from over 90 per cent in leaf fats down to a small percentage in other raw materials. Using a conservative figure of only 20 per cent for the yield of such "scrap" (the residual matter from lard) and cracklings, the by-product from edible fat would be about 250,000 tons. This is of course merely an approximation; we have no quantitative data. While a portion of the cracklings from edible fats goes to food uses (potted meats, sausage, scrapple, crackling flour), the bulk of it goes to feed, mainly for poultry. Blood, available in substantial though much smaller amounts, is generally mixed with digester tankage. The fertilizer industry also

Industry of the United States of 887,934 tons of "tankage, etc." in 1914 and 689,753 tons in 1919. In 1921 the same source reported a production in the wholesale slaughtering and meat-packing industry of 262,521 tons of "fertilizer and fertilizer materials" and 131,055 tons of stock feed. How much of these figures consists of materials other than tankage (grains, oil cake, molasses) or of purchased materials or ingredients, it is impossible to say.

utilizes steam bone and a variety of tankages from glue works, leather scrap, hair, and so forth.

In short, it is safe to say that the total production of tankage, cracklings, and similar products for feeds and fertilizers exceeds a million tons. This is a huge figure; in protein content the amount available for feed nearly equals the domestic supply of millfeeds from wheat. In addition, large quantities of green tankage or offals, and garbage, are fed to hogs.

TRENDS IN PRODUCTION OF GREASE, TALLOW, TANKAGE, AND CRACKLINGS

In the absence of other data, the best way to ascertain the relative importance of the different sources of animal wastes and the conditions of salvage is to examine the production of greases and tallow, the main products. It does not cover the whole field of waste; but in no other way can we gain so comprehensive a view, and so clear an insight into the problems and possibilities of salvage. It furnishes the clue to current developments.

Inedible greases and tallow have been considered as a unit in the preceding discussion of trends of production. Because the two are derived from different classes of animal matter, the separate record of each is enlightening with respect to trends in the recovery of different kinds of such matter.

It seems preferable to begin closer analysis with the year 1919. The more important changes began with that year; it also marked the beginning of the census figures upon fats and oils production. The earlier data were compiled by the United States Food Administration, which did not function until after the United States entered the war in 1917. For the purposes of war control and licensing it requested producers to report back for five years, to 1912. Thus the output of producers who

dropped out of the business between 1912 and 1917 was omitted. Probably these were few because the industry was growing. Again, the Food Administration figures included some quantities of edible with inedible tallow. Because of the probability that packers' practice during the war years 1916-18 changed in respect to materials devoted to edible tallow, oleo stock, oil, and stearin, an estimate of the amount of edible tallow during these three years seems subject to a large margin of error. For all these reasons it seems best to commence detailed comparisons with 1919.

The production of inedible tallow, as shown by Table 4 and Chart 1, has increased more rapidly since 1919 than has that of animal grease. In 1919 the latter was about 6 million pounds larger; by 1926 tallow was the larger to the extent of nearly 80 million pounds. Between 1919 and 1926 its production increased by about 173 million pounds, or 69 per cent; that of grease, only 88 million, or 30 per cent. The excess of tallow was reduced in the following two years owing to the contraction in cattle slaughter, and substantial increase in the kill of hogs. Moreover, while condemnations in both classes fell off, the decline was much larger, proportionately, in cattle. These shifts are reflected in corresponding variations in the packers' output of the two fats. However, tallow still constitutes well over half of the combined output, and present indications suggest it will increase more largely, because the number of cattle is relatively low and of hogs relatively high. Cattle are generally believed to be near the bottom, and hogs near the top, of characteristic cyclical swings in production.

The wastes thus increasingly utilized for inedible tallow are derived mainly from cattle, calves, and sheep, chiefly cattle, since the output of beef is about 85 per cent of the combined meat yield of the three classes, with a roughly similar proportion in the total amount of waste

and offal. The excess of tallow over grease is probably actually higher than is indicated by the statistics because of an apparent underestimate of tallow production to the extent of nearly 100 million pounds (see p. 96). The relatively large growth since 1919 in the output of beef fat is especially noteworthy when account is taken of the fact that only in one (1926) of the nine years 1920-28 has cattle slaughter equaled the level of 1919. Of hogs, on the other hand, in seven of these nine years the slaughter equaled or materially exceeded that of 1919. In none of the nine years has the production of meats or total slaughter been more than 12 per cent above the level of 1919, whereas the production of inedible fat has grown substantially. In other words, the ratio of total inedible fats to meat production has materially increased. The ratio of inedible tallow per 100 pounds of wholesale beef, veal, lamb, and mutton (dressed weight) was 4.14 pounds in 1919 and 6.2 pounds in 1927, an increase of about 50 per cent. The corresponding ratios of grease to pork were 3.51 and 4.56, or an increase of 30 per cent.

There is, of course, much more by-product trimming and waste in the slaughter of cattle than of hogs; and more in the marketing and consumption of beef than of pork. Evidently, however, this does not account for the growth in tallow since 1919, because cattle slaughter and marketing ruled at lower levels. Still less does it account for the relatively large expansion in tallow, compared with grease, since hog slaughter increased materially. The data upon condemnations, no less than those on slaughter, would indicate that grease should continue to be much the larger of the two. Moreover, the yield of edible beef fat has actually declined in relation to the slaughter of cattle.

The significance of this will shortly be seen, in relation to the trend away from federal inspection and to the widely used estimates of slaughter and meat produc-

tion. A clearer view of what has been happening can be obtained by contrasting the respective output of inedible fat by slaughterers and meat packers, and by renderers.

Passing attention must be given, however, to the production of various sorts of animal grease. Whereas inedible tallow is derived almost wholly from cattle and sheep, greases come from a wide variety of materials, mainly from hogs, and secondarily from the wastes of consumption of restaurants, hotels, and households. Table 5 shows the reported statistics of production, since 1912, of the different classes of animal grease.

TABLE 5.—PRODUCTION OF PACKERS' AND RENDERERS' GREASES, 1912, 1914, 1916-28*

(Thousand pounds)

Calendar year	Garbage and house grease	Bone grease	White grease	Yellow grease	Brown grease	Tankage grease	All other grease	Total
1912.....	80,411 ^a	29,528	} Included with "All other grease" from 1912 to 1918, inclusive				95,277	155,216
1914.....	44,688 ^a	42,264					133,195	220,147
1916.....	60,212 ^a	34,389					129,571	224,172
1917.....	65,250 ^a	31,020					113,748	210,018
1918.....	53,476 ^a	24,817					165,509	243,802
1919.....	50,823	22,524	60,394	42,392	27,016	45,311	9,696	253,156
1920.....	53,140	23,749	61,229	41,366	31,860	99,779	8,555	325,678
1921.....	53,638	26,776	65,527	45,914	33,685	90,021	7,776	323,337
1922.....	64,138	27,325	82,305	56,929	43,374	73,652	12,302	360,025
1923.....	67,425	27,992	97,500	67,357	56,253	58,481	11,810	366,818
1924.....	77,878	26,762	93,630	71,200	43,777	53,290	9,960	376,497
1925.....	73,358	24,476	73,097	64,457	40,590	51,467	8,192	340,637
1926.....	79,868	22,749	72,161	66,672	42,049	50,689	12,496	346,684
1927.....	93,337	23,633	73,398	66,948	46,379	54,887	10,001	369,083
1928.....	89,372	22,384	77,951	71,570	47,512	58,537	11,253	373,579

* Data for 1912-18 from Supplement to Bulletin 769, "The Production and Conservation of Fats and Oils in the United States," 1919; 1919-28 compiled from annual and quarterly reports of the Bureau of the Census on *Animal and Vegetable Fats and Oils*. Totals computed.

^a Includes only "garbage grease." In 1912-18, house grease was apparently included in "all other grease."

It will be noted that the product derived from the wastes of consumption, house and garbage grease, is now the largest single item, constituting nearly 25 per cent of the total. Its production has increased about 80 per cent since 1919; it is indeed the only item which shows a large and virtually uninterrupted growth since the war. Second in importance is the more variable output of white grease, mainly from condemned, diseased, or dead animals, or from materials that if wholesome would be used for meats or be rendered for lard. Yellow grease, an inferior product from somewhat the same sources, and from stained or contaminated materials, ranks third. Tankage grease, which ranked first in 1920 and 1921, has since declined in absolute amount and relatively even more. Brown grease ordinarily ranks fifth, and bone grease, which has shown a tendency to decline, ranks a poor sixth. Probably much of this grade is reported under other classifications.

CHAPTER VI

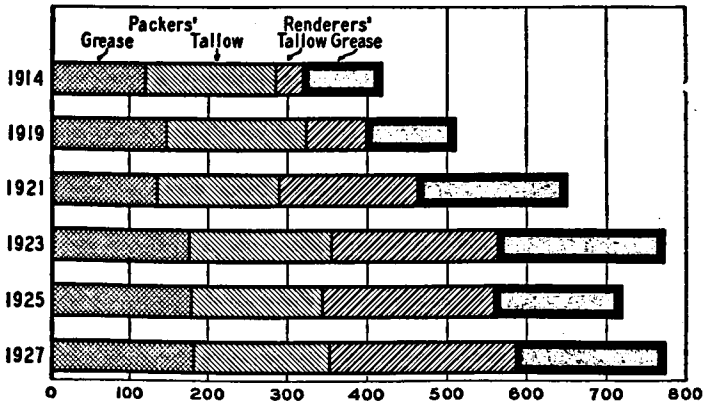
COMPARATIVE OUTPUT OF SLAUGHTERERS AND RENDERERS

SUMMARY OF AVAILABLE DATA

Trends of production, as between (a) slaughtering and meat-packing establishments and (b) rendering plants and reduction works, are indicated by census data shown in Chart 2 and Table 6 (p. 104), assembling somewhat fragmentary data from different sources. For the year 1914, as noted in the table, it has been necessary to make

CHART 2.—COMPARATIVE TRENDS OF PRODUCTION IN MEAT-PACKING AND ALL OTHER PLANTS: ANIMAL GREASES AND INEDIBLE TALLOW, CENSUS YEARS 1914-27*

(Million pounds)



* Data in Table 7, p. 107.

TABLE 6.—ANIMAL GREASES AND INEDIBLE TALLOW: OUTPUT OF SLAUGHTERING AND MEAT-PACKING ESTABLISHMENTS COMPARED WITH THAT OF RENDERING PLANTS AND REDUCTION WORKS, CENSUS YEARS 1914-27*

(Thousand pounds)

Industry and Product	1914	1919	1921	1923	1925	1927
<i>Slaughterers' and meat-packers' establishments</i>						
Tallow, including edible....	193,616	211,188	193,638	230,394	214,946	219,411
Deduct edible tallow.....	30,000 ^a	36,506	41,238	62,923	50,215	48,892
Inedible tallow.....	163,616	174,682	152,400	177,471	164,731	170,519
Grease	44,000 ^b	107,277	119,819	166,220	155,944	154,787
Soap stock ^c	76,004	39,997	16,715	11,841	23,336	27,496
Greases and inedible tallow	283,620	321,926	288,934	355,532	344,511	352,802
<i>Rendering and reduction plants</i>						
Greases and inedible tallow.	133,866 ^d	188,084 ^d	361,306 ^d	415,332 ^d	374,598 ^d	420,445 ^d
Grand total of greases and inedible tallow.....	417,486	510,010	650,242	770,864	719,109	773,247
<i>Percentages of total</i>						
Produced by slaughterers and meat-packers	67.9	63.1	44.4	46.1	47.9	45.6
Produced by rendering and reduction plants.....	32.1	36.9	55.6	53.9	52.1	54.4

* Data for comparisons obtained by collating data independently compiled from two distinct reports: for total grease and tallow and the subtracted edible tallow, the annual reports of the Bureau of the Census, *Animal and Vegetable Fats and Oils*; for the output of the slaughtering and meat-packing establishments, *Census of Manufactures*. From the latter source the 1927 figures are preliminary.

^a Rough estimate. ^b Estimate; no grease production reported for 1914. In 1919 grease and soap stock totaled 147,244,000 from a larger slaughter, but with fewer hog condemnations than in 1914. For 1914 we suggest a round figure, for grease and soap stock combined, of 120,004,000 pounds.

^c "Soap stock" in census terminology is apparently a form of grease (*Census of Manufactures, 1923, p. 804*). In later years there is an apparent tendency to report most of the product as grease.

^d Obtained by subtraction. See text, p. 105.

estimates for two items based upon data for later years, but these estimates are believed to be fairly accurate.

The output attributed to the rendering and reduction plants is a residual figure. For the odd years (1921, 1923, and so on) the biennial census of manufactures reports the production of the slaughtering and meat-packing establishments. Total production of the different fats and oils is reported annually and quarterly by another division of the same agency, the Bureau of the Census. This special report, like a few for other industries, is the result of the demand of the trade for more frequent and comprehensive data of this kind. Tables 6 and 7 have been constructed by subtracting, for the odd years, the packers' output of inedible fat from the total.¹ With substantial accuracy, however, we may credit the entire output outside of the slaughtering and meat-packing establishments to the rendering and reduction plants. From the value of tallow and grease reported in the census as having been produced in other industries, 5.7 million dollars in 1925 (see Table 3, p. 90), it would appear that such industries produced about 15 per cent of the total here credited to the rendering and reduction plants. Roughly, this incidental production, consisting mainly of grease, is about 60 million pounds. It is a product of plants primarily engaged in the manufacture of fertilizer, mixed feed, glue and gelatin, casings, sausage and "other food preparations." To the extent that these produce inedible fat, most of them are in fact renderers, but are elsewhere classified in the census according to the product of chief value.

As shown by Table 6, it is the rendering industry that has contributed the bulk of the increase in inedible fats. Of the annual production, the proportion supplied by the slaughterers declined from 67.9 per cent in 1914 to 44.4 per cent in 1921, and has been only a little higher in sub-

¹ The rough estimate for 1914 may conceivably be in error to as much as 10 per cent. Even so, the trend is striking, and it seems more likely that the share of the output of 1914 attributed to slaughterers has been overestimated.

sequent years, the percentage for 1927 being 45.6. In absolute figures the slaughterers' output rose considerably during the years 1914 to 1919, but the subsequent trend is not clearly defined. In 1921 production fell off materially; thereafter it rose to a point slightly above the 1919 level. These fluctuations seem roughly to parallel shifts in the volume of slaughter and meat production, indicating that slaughterers limit themselves largely to the processing of offals that arise within the plant.¹

In contrast, the combined output of the rendering and reduction plants shows a notable and nearly uninterrupted expansion. In 1914 they produced 32.1 per cent of the total; in 1919, 36.9 per cent; in 1921, 55.6 per cent; and in 1927, 54.4 per cent. In volume the output of these establishments rose from about 134 million pounds in 1914 to 188 million in 1919, and again to 415 million in 1923. Evidently the major expansion occurred between 1919 and 1923, a period when the slaughterers' output rose only slightly—34 million pounds compared with over 227 million for renderers. After a recession in 1925, the output of the renderers rose to a record level of 420 million in 1927, the latest year for which such data are available. In the same year the packers' production was 353 million pounds. The rendering industry seems to be growing steadily. It seems a fair inference from these and other data that during recent years a large number of rendering plants were installed in different sections of the country.

A clearer indication of the influences back of these divergent trends may be obtained by comparing the record of the slaughterers and renderers in respect to greases and tallow, as summarized in Tables 7 and 8. Since the combined slaughter of tallow-yielding animals, mainly cattle, has remained at or below the level of 1919,

¹ See Table 9, p. 118.

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while that of hogs has been in general at considerably higher levels, one would expect to see a relatively large increase in grease. As indicated above, the contrary is the case.

TABLE 7.—TALLOW AND GREASE PRODUCTION BY THE SLAUGHTERING AND MEAT-PACKING, AND RENDERING AND REDUCTION INDUSTRIES, RESPECTIVELY, 1912, 1914, 1916-28*

(Thousand pounds)

Calendar year	Inedible tallow			Animal greases			Tallow and grease		
	Packers	Others	Total	Packers	Others	Total	Packers	Others	Total
1912.....	.....	.....	202,946 ^a	.....	.....	156,216	.....	.....	358,162 ^a
1914.....	168,616	83,728	197,339	120,004	100,148	220,147	283,620	138,866	417,486
1916.....	.....	.....	275,511 ^a	.....	.....	224,172	.....	.....	499,683 ^a
1917.....	.....	.....	268,825 ^a	.....	.....	210,018	.....	.....	478,843 ^a
1918.....	.....	.....	304,891	.....	.....	243,802	.....	.....	548,693
1919.....	174,682	77,172	251,854	147,244	110,912	258,156	321,926	188,084	510,010
1920.....	.....	.....	263,990	.....	.....	325,678	.....	.....	589,668
1921.....	152,400	174,505	326,905	138,534	186,803	323,337	238,934	361,308	600,242
1922.....	.....	.....	302,818	.....	.....	360,025	.....	.....	722,843
1923.....	177,471	206,575	384,046	173,061	208,757	386,818	355,532	415,332	770,864
1924.....	.....	.....	388,295	.....	.....	376,497	.....	.....	764,792
1925.....	164,731	213,741	378,472	179,760	160,857	340,637	344,511	374,598	719,109
1926.....	.....	.....	425,210	.....	.....	346,684	.....	.....	771,894
1927.....	170,519	233,645	404,164	182,288	186,800	369,088	352,802	420,445	773,247
1928.....	.....	.....	391,682	.....	.....	373,579	.....	.....	765,261

* For sources, see Tables 4 and 6. Comparative figures computed from reports of the Census Bureau. Dots (...) indicate that data are not available.

^a Includes about 25 to 30 million pounds of edible tallow.

Of total inedible tallow, the renderers' proportion rose from 17.1 per cent in 1914 to 30.6 in 1919, again to 57.8 in 1927. In other words, in 1914 the slaughterers and meat packers produced five times as much inedible tallow as did the renderers; in 1919 only two and one-half times as much, and in 1927 renderers' tallow was the larger by 63 million pounds. Of renderers' grease, on the other

hand, the proportion changed relatively slightly: from 45.5 per cent in 1914 to 57.8 in 1921, falling to 50.6 in 1927. Here the net position of the two sources of supply remains comparatively unchanged. Since 1919 there has been some increase in the grease output of slaughterers and meat packers, although this increase does not appear to have been commensurate with the rise in hog slaughter. Of inedible tallow, the slaughterers' output has on the whole declined.

TABLE 8.—PERCENTAGES OF TALLOW AND GREASE PRODUCTION BY SLAUGHTERING AND MEAT-PACKING, AND RENDERING AND REDUCTION INDUSTRIES, RESPECTIVELY, CENSUS YEARS 1914-27

Product	1914	1919	1921	1923	1925	1927
<i>Inedible tallow</i>						
Packers	82.9	69.4	46.6	46.2	43.5	42.2
Others	17.1	30.6	53.4	53.8	56.5	57.8
<i>Animal greases</i>						
Packers	54.5	57.0	42.2	46.0	52.8	49.4
Others	45.5	43.0	57.8	54.0	47.2	50.6
<i>Tallow and greases</i>						
Packers	67.9	63.1	44.4	46.1	47.9	45.6
Others	32.1	36.9	55.6	53.9	52.1	54.4

An increasing proportion of the renderers' output consists of tallow. Between 1914 and 1927 it rose nearly sevenfold, a net increase of about 200 million pounds, most of it since 1919. The growth in renderers' grease was only 86 million pounds during this period, or about 85 per cent; and the bulk of it, as was to be expected, seems to be in the item of "house and garbage grease" (see Table 5, p. 101), which is the product of rendering and reduction plants. In 1914 grease was about three times as much as tallow; the latter gained rapidly, however, and by 1927 was the larger by some 47 million pounds.

QUALIFICATIONS

A few words of explanation and qualification need to be added with respect to these data, particularly in view of certain misconceptions that are fairly current in the trade.

For an objective measurement of the development of these industries we must turn to official statistics collected with this purpose in view. These statistics contain no element of estimate; they are merely the tabulation of reports required of producers under the various laws respecting the work of the Bureau of the Census. The clerical accuracy of the collecting agency is high; individual reports are checked for obvious errors; and in the course of years business has become accustomed to returning the required data. Falsification and refusals to report are relatively few and unimportant. If the schedule of desired information is clearly and adequately drawn,¹ there is scant likelihood of overstating production. There is always some understatement, owing to the omission of small or delinquent producers. Much depends upon the completeness of the mailing list of the statistical organization.

In the present instance the quoted official statistics probably portray the trend of production reliably. They cannot, however, be implicitly accepted for completeness. The report for the packers' production is probably fairly comprehensive, because the value of production of the average plant is relatively high. Moreover, it bears internal evidence of reasonable completeness, especially in its close relationship to meat production. The available information, however, indicates that the mailing list of the Bureau of the Census has not been expanded to include the large number of small rendering plants that have sprung up in recent years throughout the country. It is difficult for federal statistical agencies to maintain a complete list of small plants of this kind, which, more than in most manufacturing industries, have a tendency to

¹ Unfortunately many of these schedules have not, in the listing of products, kept abreast of important changes in industry. Leading products are often omitted or merged in catch-all classifications, and the designations sometimes lead to confusion.

come and go; and the assembly of such reports entails a disproportionate amount of effort. Because evidence of the development of the rendering or "scavenging" business has here been made the basis of some significant conclusions, it seems desirable to go into this matter a little further.

For the "grease and tallow industry"—rendering plants and reduction works—the biennial census of manufactures collected data on quantity of output for the first time in 1927; earlier statistics related only to value of product. Through the courtesy of the Bureau of the Census, this report has recently been made available to us in preliminary form. The report covers 247 plants whose product of chief value was grease and tallow, or less than a third of the 913 plants of this kind listed in an inclusive trade directory. However, the plants omitted are small producers; doubtless the report covers the great bulk of the output of the renderers. The summary figures from this report are compared below, in millions of pounds, with the figures for the same year in Table 7, based upon an independent report issued by the Fats and Oils Division of the same federal bureau. As already explained, in the latter table the renderers' (non-packer) output has been calculated by subtracting the packer output from the total reported by all producers, including glue and gelatin plants, and so forth.

	Biennial census (247 renderers)	Table 7 (Total non-packer output)
Grease	104.4	186.8
Inedible tallow	295.6	233.6
	<hr/>	<hr/>
	400.0	420.4
Tankage	305.6	.....
Cracklings .....	.....^a	.....

^a Not stated separately.

Manifestly the biennial census of the rendering industry should show a smaller output than total non-packer production in Table 7. Total production, and grease production, are in fact lower; but the tallow output is larger than that com-

puted in Table 7, by about 62 million pounds. Probably the more hurried quarterly and annual reports of total fat and oil production upon which Table 7 is based understate total output, because these also report a consumption materially in excess of production. The understatement is more serious in tallow, because there are a considerable number of small rendering plants which produce only this class of fat. It is less serious in grease, which is produced chiefly by larger establishments, located in the densely populated centers.

Be all this as it may, the statistics given in this recent report tend to confirm and emphasize our conclusions with respect to the relatively large growth in the renderers' output, especially of beef fat. The biennial census report, covering most of the industry, shows a production of 400 million pounds, of which tallow is 295 million, or nearly 75 per cent. It will shortly be seen that the predominance of this fat is merely an incident of interesting developments in the distribution and consumption of meats.

PROBABLE EXPLANATIONS

Plainly the raw material of the rendering plants is increasingly derived from cattle, calves, and sheep. The significant point in the immediate connection is not the growth of this salvaging business, nor even the absolute rise in its tallow output. Both facts may be accounted for in a number of ways. It is the disproportionate increment of such fat that seems to be suggestive. According to the biennial census of 1927, inedible tallow constituted about 74 per cent of the renderers' output of inedible tallow and grease; according to Table 7, it was 56 per cent in 1927, 41 per cent in 1919, and 25 per cent in 1914. It has already been suggested (p. 27) that a growth in the slaughter under state or local inspection, or a trend away from federal regulation, should be registered in a larger output of this fat. If processed by the unofficial establishments, the packers' output should record an increase relative to the cattle kill, calves and sheep being compar-

tively unimportant. If the offals are sold to rendering plants, it should register in a large increase in the inedible tallow produced by such plants. The last seems to be precisely what has occurred. In the packers' production there has been virtually no growth during the past decade. If the large increment in the output of the renderers has been mainly the result of the erection of new plants in areas not so served, or of an enlargement in the territory covered by their trucks, we should expect to see at least a roughly proportionate rise in grease. However, the growth in renderers' tallow since 1919 has been nearly 2½ times as large as in grease. The slaughter of tallow-yielding animals has shown virtually no increase. Hog slaughter has materially increased.

In the absence of recorded information upon this subject, or of quantitative measures of the different raw materials that go to the rendering plants, the various causal factors are not easy to assess. The industry is widely scattered; the material that goes to the large city plants varies in its constituents from that available to plants in the small cities and towns. There is a growing tendency to specialization in distinct classes of material; for example, some plants produce only house grease, others specialize in butchers' by-product, and so forth. For such reasons the views of informed persons—producers, brokers, equipment manufacturers—vary widely, according to the locality or region in which they operate and the particular branch of the business in which they are engaged. Nevertheless, upon certain facts there is fair agreement; and these facts present an interesting sidelight upon certain aspects of the food industries.

It is stated, for example, that the materials for grease available to renderers have been dwindling in volume. A striking development has taken place in the purveying of foods by drug stores, soft drink parlors, tobacco shops, and by small establishments in the countryside along the

lanes of motor travel; and collaterally there has been a remarkable growth in the consumption of quickly prepared foods. Renderers do not find it profitable to collect the wastes from such small and widely scattered establishments. The city restaurants and hotel dining-rooms, it is added, have been losing ground; the American public takes its food "on the run"; "dining has become a lost art." Furthermore, restaurants utilize foods more efficiently; and in many areas hog feeders take materials that formerly went to renderers. All these influences should be reflected in the production of house grease, made from food wastes; and the reported decline in municipal reduction should be reflected in garbage grease. It will be observed from Table 5, however, that since 1919 the combined production of house and garbage grease has in reality grown by about 80 per cent, and that the increase has been a fairly consistent one. The fact remains, notwithstanding, that the successive advances have been at a much slower pace than those in tallow. That there has been an absolute rise in renderers' grease at all in the face of the facts suggested—facts that are in line with common knowledge—is no doubt the result of offsetting influences: a greater *total* patronage of hotels and restaurants owing to the growth of cities, increase in travel, the larger number of apartment houses, and so forth; and a greater waste owing to objections to fatty foods.

In still another source of grease a decrease appears actually to have occurred. Formerly relatively large numbers of dead, dying, and crippled hogs arrived at the packing centers. In such centers these constituted a fairly important part of the material that went to the rendering plants. Such losses have been greatly reduced; but so, also, have similar losses of tallow-yielding animals.

All in all, it may be granted that influences such as the foregoing have tended somewhat to retard the growth

in grease production. It remains to consider the causes for the disproportionate increase in output of renderers' tallow. Now the raw material for such fat available to the rendering plants consists of slaughterhouse offals of cattle, calves, and sheep, the shop fats of meat distributors and meat markets, and dead or condemned animals of the stated classes. That there has been a substantial decline in the number of animals from the cities appears to be certain; likewise a decline in the number of dead or crippled stock arriving at the stockyards; but these have probably been offset by the increasing supply of dead stock from dairy farms near cities. It is reported, also, that in sections of Ohio, Indiana, and Iowa farm animals constitute one of the principal sources of tallow as well as of grease. Furthermore, in the supply of butchers' scrap, suet, and bones there has been a notable increase. For reasons already indicated, such trimmings consist almost entirely of materials for tallow. The growth in this source of supply is the result not only of the concentration of population in urban areas, but also of a greater amount of trimmings and waste, owing to the demand for small and lean cuts.¹

Finally, slaughterhouse offals from plants under state and municipal inspection are an important and growing source of renderers' tallow. There are no data upon the dimensions or trend of the commercial kill outside of federal inspection. The available information does not support the common notion, in part based upon rough official estimates, that such slaughter shows a downward

¹ The suggestion has been advanced that the aggressive campaign for the eradication of bovine tuberculosis has effected an addition to the tallow output. It has resulted in a considerable slaughter of reactor cattle, mainly dairy stock. In 1927 the slaughter of reactor cattle was 207,380 head, and the average salvage per head, \$30.69, indicating that after slaughter and post-mortem examination it was found that the animals could largely be used for food. Probably a considerable proportion of heads and viscera was condemned. In any event such condemnations would be reflected in the packers' product, and would have little relation to renderers' tallow.

trend. Obviously it is a matter of considerable importance. If we allow for an increase in tallow proportionate to that in grease, and estimate the yield of tallow from such locally slaughtered animals at, say, 30 pounds per head, then in terms of cattle the increment in such slaughter between 1914 and 1927 would be at least between 4 and 5 million head. No doubt this is much too high; the federally inspected slaughter in 1927 was only 9.5 million head, and a substantial part of the growth in renderers' tallow must be ascribed to the larger volume of butchers' scrap and perhaps of dead animals from the farms. Yet in 1909 the combined retail and local wholesale cattle slaughter was 4.4 million animals; and local wholesale slaughter trebled between 1909 and 1927, from 401 to 1,205 million animals (see Table 12, p. 159). It should be noted, also, that frequently, especially in areas not served by renderers, offals are fed to hogs; that a good deal of local tallow is used to adulterate lard; and that the official reports for tallow production are about 100 million pounds less than the estimated consumption plus net exports, apparently owing to the exclusion of the production of "local butcheries and meat markets."

Again, the suggestion has been advanced that a material decline has taken place in the proportionate receipts of canner and cutter stock at the important packing centers, and in consequence a shortage has developed in the type of lean beef used in products such as sausage. Now canner and cutter stock are mainly dairy cattle; and since the proportion of such cattle has increased, it seems an obvious conclusion that surplus and discarded dairy cattle are increasingly going to the local plants. The situation with respect to calves is somewhat similar.

In short, the evidence seems clear that there has been a substantial growth in local slaughter, although it is improbable that it has expanded to the extent suggested by the data for inedible tallow.

Another qualification should here be made. In comparing the trend of tallow and grease production, some allowance should be made for the practice of mixing materials for these fats according to current prices of the products. It is among renderers that such mixing is the more prevalent. It appears, however, that the average annual price of white grease since 1921 has been higher than for the high grade of tallow termed "prime packers," and the price spread between prime packers' tallow and a representative low grade of grease, yellow grease, has narrowed, from a difference of 2.2 cents per pound in 1921 to 1.1 cents per pound in 1927. In 1925 the spread between the two was only 0.8 cents per pound.¹ These figures are probably representative. Moreover, materials for non-packer grease are of inferior quality—the wastes of households and public eating places. These yield a grease that is dark in color, high in free fatty acid, and with a relatively high percentage of impurities. A large admixture of such materials would so lower the grade (and price) of the resulting tallow as to offset such benefits as might otherwise be obtained. Packers have less incentive for such mixing, for their grease is in the main of higher quality, and much of it is further processed for derivatives such as lard oil, red oil, and stearic acid.

It is a fact, however, that portions of the tallow-consuming trade complain that much of the tallow of today is inferior to that of former times. It is less hard, the titre is lower. This is commonly attributed to its having been mixed with grease by renderers. If this were the result of a price incentive, one would expect to see a similar practice among packers. Yet the output of packers' tallow has slightly declined and that of packers' grease greatly increased. Factors other than price may

¹ See Appendix Tables I and II, pp. 309-11 and 312-14.

also play a part. A tallow of lower titre is produced from the offals of stock that is in poor condition, or from aged dairy animals, and local slaughterers kill a relatively large proportion of dairy stock. Shop fats, of which there is an increasing supply, also yield a softer tallow. On the whole, it is possible that the figures for tallow production are swelled and the figures for grease diminished appreciably by this practice. To what extent this is offset by the feeding of offals or by the underestimate of production, it is impossible to say. The situation is complex, recorded information is scanty, and the views of the trade are often influenced by regional and temporary conditions.

RELATION OF SLAUGHTER TO FAT PRODUCTION

Because the collateral sanitary and economic aspects are of serious import, we shall press the analysis somewhat further. In the preceding discussion we have dealt with the significance of the rise in the renderers' output. It seems desirable to examine the data upon the fat output of the slaughterers, especially the ratio of such fats to the slaughter. Unfortunately, the pertinent official statistics do not include either the fat output or the large kill of the retail plants. They cover only the wholesale plants, combining those under and outside of federal inspection. Now while the local or non-federally inspected wholesale kill of cattle (see p. 159) trebled between 1914 and 1927 (compared with an increase of about 25 per cent for the interstate kill), it is still only about 12 per cent of the combined figure. Therefore, changes in the practice of the local wholesale plants would only slightly affect the totals. And there are no quantitative data upon the extent to which slaughterers collect and render outside wastes. For what they may be worth, however, the data are presented in Table 9 (p. 118).

TABLE 9.—COMPARISON OF SLAUGHTER AND FAT PRODUCTION IN WHOLESALE (INTERSTATE AND LOCAL) SLAUGHTERING AND MEAT-PACKING ESTABLISHMENTS, CENSUS YEARS 1914-27*

Product	1914	1919	1921	1923	1925	1927
<i>Hogs slaughtered (millions).....</i>	84.4	44.5	40.7	57.0	48.1	47.5
<i>Grease produced (million pounds)...</i>	120.0	147.2	186.5	178.1	179.8	182.3
<i>Grease produced per hog (pounds)..</i>	3.5	3.3	3.4	3.1	3.7	3.8
<i>Beef, veal, lamb, and mutton produced (dressed weight, million pounds)..</i>	4,622	6,076	5,364	6,202	6,590	6,517
<i>Inedible tallow produced (million pounds)</i>	163.6 ^a	174.7	152.4	177.5	164.7	170.5
<i>Inedible tallow produced per 100 lbs. dressed weight (pounds).....</i>	.....	2.87	2.84	2.86	2.50	2.61
<i>Edible stearin, oleo oil, and edible tallow produced (million pounds) .....</i>	.....	234.5	259.6	283.5	265.5	243.8
<i>Edible stearin, oleo oil, and edible tallow produced per 100 lbs. dressed weight (pounds)^b .....</i>	.....	3.86	4.84	4.57	4.03	3.74

* Data from U.S. Bureau of the Census: *Census of Manufactures (Slaughtering and Meat Packing); Animal and Vegetable Fats and Oils.*

^a This figure includes a limited but indeterminate amount of edible tallow; hence the yield for 100 lbs. dressed weight cannot be reliably computed.

^b Exclusive of oleo stock, which is not reported; this is probably offset by inclusion of some quantities of lard stearin and "edible stearin."

In the operation of a slaughtering plant the major source of inedible fat is the inedible offal from sound animals. The supply of such materials varies with the volume of slaughter. Condemned animals, or parts of carcasses, constitute a more variable supply, doubtless responsible for a measure of difference between trends in slaughter and in packers' output of inedible fat. Particularly in the case of hogs, the growing prevalence of hog cholera and tuberculosis (up to 1926) accounts for part of the rise in packers' grease. Only a portion of the carcass, however, is usually barred from food use by the more frequent causes of condemnation, excepting hog cholera. Consequently, while condemnations for disease have on the whole been increasing, relative to slaughter

the increase does not appear to have been large enough greatly to affect the packers' output of grease and inedible tallow.

Scrutiny of the available data regarding the slaughtering and meat-packing establishments, in respect to slaughter and the output of inedible fats, tends on the whole to confirm the conclusions previously drawn. From Table 9 it will be noted that the trends here are just the reverse of those in the rendering industry. In the slaughtering plants the output of inedible tallow was larger than that of grease prior to 1921. Its output, although variable, has shown virtually no increase. Grease is now the larger of the two, with an increase of 62 million pounds, or about 50 per cent, between 1914 and 1927. This was of course to be expected in view of the growing hog slaughter.

From this table it will be noted that the yield of grease per hog slaughtered has remained within a range of 3.1 and 3.8 pounds, or a maximum spread of less than 23 per cent. Disregarding the doubtful figure for 1914, a considerably smaller range appears in the yield of inedible tallow, using the dressed weight as a common denominator for the slaughter of cattle, calves, sheep, and lambs. But the yield of oleo oil, stearin, and edible tallow has declined since 1921 when compared with this combined dressed weight. The figure for 1919 is out of line, possibly because of the war and post-war conditions which affected packing-house practice.

To repeat, these figures are not conclusive and need qualification. There are no quantitative data to show whether slaughterhouses are increasingly bringing in outside animal wastes for rendering. Depending upon their nature and upon regulations, these may be rendered for either edible or inedible fat. Moreover, the census does not report retail slaughter, either in respect to the kill or to fat production. Were the latter reported, it would swell the figures for inedible fat, especially tallow. On the

whole, however, the available data indicate a considerable increase in the slaughter outside of federal inspection. Indeed, with the growth in the number and size of small cities and towns, the development of local dairying and mixed farming, a rise in the number of such small slaughterers seems a logical development. We shall attempt now to consider in turn certain economic and other aspects of production by slaughterers, renderers, and municipal reduction works.

CHAPTER VII

PRODUCTION OF INEDIBLE FAT BY MEAT PACKERS

ORGANIZATION AND PRACTICES OF THE INDUSTRY

Of slaughterers there are four principal groups: (1) wholesale slaughterers operating interstate (federally inspected or "official") plants; (2) wholesale slaughterers operating local plants; (3) small retail butchers, meat markets, and peddlers who slaughter for a local retail trade; and (4) farmers, whose kill is mainly for farm consumption. Only the first group operates under federal regulation; and such regulation applies to their entire edible product, whether or not it is shipped beyond the state. A fifth and relatively small group, the custom or co-operative slaughterers, is properly classed with the wholesale plants. Most of these operate under local regulation, and slaughter for the account of wholesalers, retailers, and farmers.

Upon retail and custom or co-operative slaughter, and upon sales of farm meats, statistics are either entirely lacking or are so old as to have scant present application. From the fragmentary data that are available, it would seem that a considerable proportion of the domestic meat supply comes from such sources. Of the total number of "wholesale slaughtering and meat-packing establishments," 1,249 in 1927, about 66 per cent were under federal inspection. By no means all of these are large plants. In 1925, the latest year for which such census data are available, 329 wholesale plants, 26 per cent of the total number, produced 93 per cent of the total wholesale product, their aggregate output being valued at 2.8 billion dollars. About 31 per cent, or 398 plants, reported outputs

of \$100,000 or less. An annual production valued at about \$100,000 would represent a daily kill of only a few animals, or hardly more than a score of cattle weekly. Another large group, of 400 plants, reported outputs of between \$100,000 and \$500,000.¹

Doubtless most of the large producers are in the interstate trade; but there are also a considerable number of small plants doing an interstate business. Conversely, a number of fairly large plants are engaged in an exclusively intrastate trade. These distinctions are important for the present purpose.

Of the concerns under federal inspection, a few, such as the "Big Four," are engaged in a business that is national or international in scope, with a far-flung organization that embraces by-product subsidiaries, car routes, branch storage houses, and so forth. A larger number are "regional packers"; that is, their business is in a relatively compact or homogeneous territory em-

¹ The classifications adopted by the census materially lessen the usefulness and significance of such data. In this instance they cover the "wholesale slaughtering and meat-packing industry," including many plants which do only a meat-packing (curing and processing) business and do not slaughter livestock. Since such packers buy raw materials from the slaughterers, there is considerable duplication in the reported 3 billion dollars of total product. The two classes are not segregated. In addition, even large integrated concerns frequently buy green meats, hides, unrefined lard, and the like, for further processing. Moreover, the Census Bureau states that the quoted data for 1925 are exclusive of about 94 million dollars of meat products produced in plants assigned to other classifications. They are also exclusive of about 80 million dollars of sausage and sausage casings produced in plants primarily engaged in sausage manufacture. Sausage, and so forth, produced by plants primarily engaged in "slaughtering and meat-packing," are included in the data for that industry.

The interstate wholesale slaughter is more concentrated than the entire wholesale slaughter. The report of the Chief of the Packers and Stockyards Administration for 1927 (p. 7) states that the Division of Audits and Accounts received reports from 356 interstate (federally inspected) concerns, of which 198 slaughter livestock and 158 do not. Of the total federally inspected slaughter in 1925, 70.3 million head, the 198 reporting plants killed 68.4 million head, or 97.3 per cent.

The census data relate chiefly to establishments or plants, not to ownership. The data reported under the Packers' and Stockyards Act represent concerns. A few national and regional meat packers, controlling a considerable number of plants, would account for the bulk of the interstate slaughter.

bracing several states, and is much less diversified in respect to the number and variety of products. There is a third group of official or interstate concerns—a considerable number termed “local packers”; their business is mainly local, usually centered in a large city, but part of it moves interstate to contiguous markets or the steamship trade. Except for differences arising from inspection, the operations of such producers resemble those of the larger wholesale concerns under local inspection.

That the utilization of by-product varies materially in different classes of meat-packing establishments has already been noted. Even individual plants alter their manipulation and use of materials according to market conditions and the available volume of different kinds of by-product. It is with the most efficient or intensive practice, as exemplified by the federally inspected national or international meat packers at the great packing centers, that the literature on modern packing-house methods is primarily concerned. In important details these methods are not practicable for plants of medium or small size, of which there are large numbers scattered throughout the country. The causes of variation are twofold. One is economic, arising from differences in volume, breadth of market, and efficiency. The second is the result of sanitary restrictions. In their broader and more significant aspects, economic and sanitary conditions have already been considered in earlier sections dealing with fundamental factors. Here it suffices to indicate further a few more direct applications.

The national or international packer produces a larger number of classes and grades of product from a given class of raw material because the products of subsidiary enterprises—soap, lard substitutes, oleomargarine, glue and gelatin, fertilizer, pharmaceuticals—provide a better and more stable market, and because volume warrants the additional cost of segregating and processing different

classes of animal matter. Yields of inedible fat are kept down to a minimum. In such plants a low percentage of inedible fat, and a high proportion of the better grades such as white grease and prime tallow, are regarded as indices of efficient packing-house operation. An equal degree of specialization is not profitable for many regional or local packers. These are primarily concerned with the purveying of meats, and adapt their product to the distinctive local or regional demand for various meat foods. By-products, being mostly perishable, must be processed; but it seems to be the tendency to dispose of such materials in the simplest manner, with the minimum expenditure of labor and a minimum investment in machinery. In the aggregate, a large quantity of edible materials is rendered for grease and tallow.

The sanitary regulations introduce another important cause of variation in plant practice. Concerning the effect of the multiple systems of regulation, especially upon the production of fats, something has already been said. Not being subject to federal meat inspection, many local plants are in position to employ in foods materials and processes forbidden to interstate establishments; but this comparative freedom from restrictions is offset by limitations upon their markets. In official plants the background of sanitary regulation is an integral part of operating technique. Such regulations exert both a direct and an indirect influence upon by-product utilization. The influence of the sanitary restrictions is partly direct, in requiring rejection of certain types of material for food use, and in specifying what materials may go into various products and what processes and labels may be used. It is partly indirect, in the sense that certain restrictions respecting meats and edible fats increase costs, and result in the rendering of much edible material for industrial fats.¹

¹ For example, considerable quantities of meat are "passed for sterilization" (cooking) and the cooked product labeled accordingly. A packing plant

It should be noted, furthermore, that the different sorts of material that are rendered are not treated in the same tank. A federally inspected plant is required to have two tanks or sets of rendering tanks, one for edible and the other for inedible fat. In practice, large establishments frequently find it necessary or desirable to operate three sets, and this applies for tallows as well as for hog fats: one set for the edible products, the various grades of lard, oleo stock and its derivatives; another for the grease or inedible tallow from sound animals; a third for the rendering of animals or parts of animals condemned because diseased. The first of these is located in the packing house proper, technically known as the edible department of the plant. The other two sets must be located in a separate and strictly segregated part of the plant, technically known as the inedible department. The inedible department is practically a separate factory, a rendering plant (see pp. 175-208), over which the Meat Inspection Service has only such jurisdiction as is necessary in connection with the supervision of the edible department. Some of the smaller interstate plants find it more convenient to sell offals to the renderers.

Owing to the number of by-products and the variations in use, the situation is not easy to assess. Certain facts, however, are clear. There is, as we have already

that is not equipped to produce canned or cooked meats must render such materials. Similarly, it is required that "heads for use in the preparation of meat food products shall be split and the bodies of the teeth, the turbinated and ethmoid bones, ear tubes, and horn butts removed and the heads thoroughly cleaned." Machinery has been devised for removing teeth and turbinated bones, but many plants prefer to tank for white grease the jaw and upper head bones affected by this regulation. Similarly, all pigs' feet must be free of hair, turf, and toe nails, and for this reason a good deal of this class of material goes to white grease. There are a number of similar regulations. Each additional process entails labor and other costs, and it is always a question whether the price finally obtained will warrant the expenditure. We imply no criticism of such regulations, many of which are obviously in the public interest. It is the economic effects that we are here considering. In a large plant slaughtering thousands of animals, these individually small items bulk large.

remarked, an important difference in preparing the carcasses of the different animals for shipment. Excepting canner and cutter stock, mainly used for canned beef and sausage, it is not the common practice to "break down" carcasses of cattle, calves, sheep, and lambs at the slaughtering plant. They are usually shipped to market in quarters, sides, or full carcasses, to be later divided into such cuts as are desired. Methods of cutting dressed meat vary widely in different markets because of local custom and demand. On the other hand, only a small percentage of the hog carcasses is marketed as such, this method being more frequent in the small plants. Hog carcasses are commonly divided into standard cuts (hams, shoulders, loins, backs, bellies, and subdivisions) at the slaughtering plants, and a substantial proportion of the total goes in carload lots to large distributors who also operate curing plants and sausage factories. The method of cutting varies somewhat with prices of lard and different cuts, especially fat backs, clear plates, and jowls. Except for this cause of variation in the process of division, most of the hog fat that can be separated is trimmed off at the slaughtering plants.¹

In the case of cattle and sheep, body and kidney fats go to the consuming centers with the carcass meat. In general, as much fat as is possible is marketed with the meat. It follows that the slaughterhouse by-product of cattle consists mainly of the rough offal, removed from the slaughtered animal in the course of dressing: blood, head, feet, caul, internal organs, hide and tail switch, bed trimmings (fats and tissue, bruised and soiled parts, and so forth, removed as carcass trimmings), and dressing wastes (particles of fat and tissue removed from the carcass while it is being trimmed and washed). Dressing wastes are known as floor or clean-up scrap and catch-

¹ W. C. Davis, *Commercial Cuts of Meat* (U.S. Dept. of Agriculture Circular 300), December 1924, p. 2.

basin accumulations. On the other hand, in the case of hogs, a variety of pork scrap and trimmings' results from the process of division into cuts, apart from the rough offal (blood, hair, viscera, heads, leaf fats, bed trimmings, and dressing wastes).¹ The magnitude of some classes of by-product is indicated by the statistics for official² plants.

It cannot be said that a particular type of offal necessarily goes to a certain product or process. The production of edible fats, for example, entails higher costs than does that of the inedible grades. When the market for meat specialties and fat cuts is poor, more of such material will be rendered for fat; when the spread in prices between edible and inedible fats is narrow, more of the raw material will go to industrial uses. The last applies particularly to local or regional packers, who do not especially produce lard substitute, oleomargarine, and canned foods. A plant of medium size may put the better qualities of beef fat into oleo and the rest into inedible tallow, making no attempt to produce edible tallow. At times, when prices are low, such a plant may produce only inedible beef fats. Extreme care is necessary in the preparation of oleo and special equipment is required; hence small official² establishments usually render all beef and mutton fats for edible or inedible tallow, or sell the raw material to renderers. In hog fats the situation is somewhat similar. Many plants produce only a kettle-rendered or an unrefined lard, or both, the unrefined lard being sold to the large establishments for further

¹ C. V. Whalin, *By-Products of the Slaughtering and Meat-Packing Industry* (Report of the Federal Trade Commission on the Meat-Packing Industry, Part 1), June 24, 1919, p. 548.

² As previously explained, in the reports of the U.S. Department of Agriculture the interstate plants—those subject to federal meat inspection—are commonly designated as "official" or "federally inspected" establishments; and the terms "interstate," "federally inspected" and "official" plants are here interchangeably used. In the same reports all plants not subject to federal inspection are designated as "unofficial," and sometimes also as "local." This terminology is rather generally accepted, and is here used.

processing. Occasionally, when the hog kill is small, some plants will not attempt to produce lard.¹

INTERSTATE PLANTS

From Table 10 it will be observed that in federally inspected plants, in 1928, the edible offal of cattle was 29.8 pounds per animal, or 3.15 per cent of the live weight. In the case of hogs the edible offal was 2.98 per cent of the live weight, or 6.84 pounds per animal. There is little difference in the yield of offals from different classes of cattle, the main variation being in fat and hide. The amount of edible beef fat, unrendered, was 37.1 pounds per head in 1928, or 3.92 per cent of the live weight. For inedible products the statistics are incomplete. No data are given for inedible tallow, and only hog greases are reported.

In the operation of a federally inspected plant there arises a fairly constant proportion of inedible by-product from sound animals. There are also the condemnations and animals that arrive dead or in a dying condition. Under special license and strict supervision, if it creates no nuisance, and unless city ordinances forbid, animals of this kind may be brought in to the inedible department from the public stockyards or elsewhere.² So also may

¹ A few illustrations will suffice. Paunches may be processed for tripe, but when there is little demand for this product such material goes to edible or to inedible tallow, without the expense of cleaning and processing. Blood may be used in food preparations or added to tankage. Bones may be used for either edible or inedible fat. Snouts and ears may be sold or canned as food specialties or rendered for lard or grease. A number of departmental catch basins may be used to salvage tallow and grease, or a single one may be used, yielding material for grease only; and some plants discharge such material into the sewers or streams. The increasing use of catch-basin equipment is reported to have materially increased the packers' output of inedible fats.

² In some cities only animals that have died in the packing house are rendered. Hogs that have died en route to the stockyards or that have died after arrival may not be rendered in the packing houses because city ordinances forbid rendering within city limits. This is the case in Chicago, for example, where such animals must be hauled to a rendering plant outside the city. This applies, of course, in these cities both to plants with federal inspection and to those without.

meat wastes obtained from retailers, public eating places, and so forth.

Some notion of the proportion of the inedible fat supply derived from condemnations may be obtained from

TABLE 10.—ESTIMATED YIELD AND PRODUCTION OF ANIMAL BY-PRODUCTS FROM SLAUGHTER UNDER FEDERAL INSPECTION, 1927 AND 1928*

By-product	Production (Million pounds)		Production per animal (Pounds)		Percentage of live weight	
	1927	1928	1927	1928*	1927	1928*
<i>Edible by-products</i>						
Beef fat ^a	331.7	311.6	35.12	37.11	3.71	3.92
Beef offal	270.1	251.1	28.64	29.87	3.03	3.15
Calf fat ^a	6.4	6.6	1.32	1.40	0.75	.79
Calf offal	32.4	31.5	6.67	6.75	3.78	3.83
Sheep fat ^a	27.6	27.7	2.15	2.07	2.64	2.52
Sheep offal	25.7	27.4	2.00	2.04	2.44	2.49
Hog offal	277.3	340.5	6.37	6.84	2.73	2.98
Pork trimmings	576.8	643.6	13.17	12.91	5.64	5.63
Lard, rendered	1,556.7	1,749.7	35.81	35.30	15.36	15.40
Total	3,104.7	3,389.7	.....	.....	.....	.....
<i>Inedible by-products</i>						
Hog grease ^b	124.3	135.6	2.84	2.72	1.22	1.19
Cattle hides	616.1	532.5	64.75	62.89	6.84	6.63

* Data from *Crops and Markets*, March 1928, V, 87, and March 1929, VI, 90.

^a Unrendered. ^b Rendered.

the reports of the federal Meat Inspection Service. Ante-mortem condemnations are insignificant, the total for all classes of animals being about 2,000 head in the fiscal year ending June 30, 1928. Post-mortem condemnations are reported in terms of entire carcasses and primal parts, no report being made upon condemned viscera, the number of which is large. In 1928 the number of condemnations (ante-mortem and post-mortem inspections

combined) was 252,074 live animals and whole carcasses, and 1,038,800 parts. These are "primal" parts, mainly heads, and represent substantially an equal number of animals slightly affected by disease. In addition, 54,766 animals, dead or in a dying condition, were also tanked, as well as 9,222,655 pounds of meats that became rancid or tainted in the course of storage or distribution. Although large in the aggregate, the condemnations (of carcasses and parts combined) affected about 2 per cent of the 75.3 million animals slaughtered under Federal inspection.¹

Upon the basis of these statistics, the statement is often made that the proportion of diseased meat animals is about 2 per cent. The actual proportion appears to be considerably higher. These data are apparently exclusive of rejections at the public stockyards, or those animals which go to stockyards renderers. More important is the fact that the official statistics regarding condemnations appear to relate primarily to meats in the narrower sense. They do not include another large class of condemnations—the condemned viscera. In the absence of statistics, the volume of such condemnations is conjectural. As nearly as may be determined from the trade, condemnations of viscera, while variable, approximate in number the million odd "parts" rejected. If, therefore, such condemna-

¹It should not be assumed that only about 2 per cent of all the animals shipped to the markets, or purchased by all slaughterers, are diseased. There are no data upon the percentage so affected. The following data, covering state-inspected slaughter (apparently mainly in the rural districts) of one state were obtained by correspondence, for the year 1927:

Class	Animals slaughtered	Animals condemned	Parts condemned
Cattle	144,307	3,111	33,051
Swine	131,633	700	29,453
Sheep	137,621	443	15,170
Calves	153,304	650	531

If each "part condemned" represents a separate animal, condemnations (animals plus parts) affected about 25 per cent each of the cattle and hogs slaughtered, and about 11 per cent of the sheep slaughtered.

tions be added to those of animals, entire carcasses, and parts of carcasses, the proportion of slaughtered animals (in official plants) sufficiently affected by disease to warrant condemnation in whole or in part becomes considerably larger than this 2 per cent. How much larger it is impossible to determine from the available data. Now the viscera are embedded in a rich layer of caul and ruffle fat, and such condemnations are an important additional source of inedible fat. Frequently condemned hog viscera are the most important source of "packers grease."

A federally inspected hog slaughterer desires to produce as much lard and as little grease as possible, since all the channels of trade are open to the higher-priced product, lard. His market is restricted only by his location and the kind and quantity of competition he has to meet. For grease and tankage are used only those materials which would lower the quality if rendered for lard, or which the federal inspectors do not permit to be so used. These materials are condemned hogs, condemned primal parts and viscera, dead hogs (i.e., dead otherwise than by slaughter), condemned fats, lungs, ear drums, eyes, eyelids, tonsils, bruised meats, turbinated bones, teeth, or jawbones containing teeth, pig toes, trimmings of all sorts (including some from cured and pickled meats if unfit for lard), viscera of various sorts, floor scrap and condemned pieces, catch-basin skimmings, even some lard that has been kept too long and become rancid, any edible product that may have become contaminated or spoiled. All these, it has been noted, amount to about three pounds (rendered weight) per animal slaughtered. Total inedible by-products (grease and tankage, casings, blood, hair, lungs) are about 9.38 pounds per animal, or 3.75 per cent of the live weight.

The commonest cause for condemnation of hogs is tuberculosis, which in the last fiscal year (1927-28) was responsible for about one-third of the 154,175 carcasses

condemned on post-mortem examination, and for about 60 per cent of the 877,511 "parts" so condemned. For condemned viscera there are no data. Reported rejections for tuberculosis rose rather steadily from a low figure of 31,517 carcasses in 1911 to a record of 100,010 in 1924. Since then they have dropped sharply, the figure for 1925 being 86,282 and for 1928 only 55,749. Of parts condemned, the greater proportion are hog heads with caseous (tubercular) glands, rejections of such parts declining from 1,179,301 in 1924 to 518,414 in 1928. Next in importance, as a cause for condemnation, is hog cholera, which results in condemnation of the entire carcass. Rejections for this cause were about 25 per cent of total hog carcasses condemned in 1927 and only 11 per cent in 1928. Tumors and abscesses caused the rejection of 340,154 parts in 1928. Losses from these causes vary greatly from year to year.

What proportion of the grease produced by federally inspected plants is the result of condemnations, it is not possible to determine. As stated above, the official data upon condemnations do not include viscera, which according to the trade are an important source of grease. From the official statistics already cited, however, it is evident that in the aggregate a considerable amount of grease is the result of condemnations. Furthermore, a good deal of the balance is directly or indirectly the result of sanitary regulations which specifically or conditionally prohibit the use in food of various offals from sound hogs. Did the regulations permit, doubtless a good deal of it would be rendered for lard. Certainly a large part, and conceivably at times the major portion, of the grease output of official plants is the result of condemnations and sanitary restrictions.

In the case of beef and sheep fats we have a somewhat different situation. With substantial accuracy it may be said that the entire output of commercial food fat (edible

tallow and oleo) comes from the interstate plants.¹ Yields of edible fat are of course less than they would be if carcasses were not sold in deference to trade custom with much unnecessary fat adherent. Yields vary, of course, with the kind and condition of the animals slaughtered. Presumably the proportion of trimmings and bones is greatest when the carcass is "boned out," that is, cut up, the bones removed, and the meat canned, cured, or directly sold, but the canner and cutter stock mainly used for this purpose are lean animals. However, in interstate plants but little of sound edible trimmings or edible offals need be rendered. There is a large outlet in sausage and potted, dried, or other manufactured meat products. Above all they may be canned. Even sausages, if they cannot be disposed of promptly, may be held over by canning. Large concerns usually operate canning departments; small interstate concerns commonly sell their canning-grade materials to canners. As we shall see, the situation is different in local plants.

Into the production of inedible tallow go much the same parts and materials from cattle and sheep that go into grease when hogs are slaughtered. Briefly, these are contaminated or unfit materials of various kinds, condemned animals (as well as those which arrive dead or in a dying condition), carcasses of meager or emaciated animals, slunks, immature calves, and so forth. Federal condemnations of sheep and lambs are insignificant. Of cattle, such condemnations of carcasses rose from a low point of 27,933 in 1907 to a peak of 103,636 in 1926, receding to 69,446 in 1928. Condemnations of parts have ranged

¹ There is some trade in unrendered beef fat or suet. Some classes of consumers prefer suet to commercial shortening. Unrendered fat, especially hog fat of neutral lard grade, is occasionally sold to margarine manufacturers. Only animal products that have passed federal inspection may be used in margarine, and therefore such sales are made only by official plants. There was also formerly a considerable export of unrendered fats of oleo grades, especially to France. This export has dwindled, apparently because American packers prefer to export the rendered product.

between 161,000 and 210,000 in recent years. Tuberculosis has been responsible for about two-thirds of all rejections of carcasses, or about twice as many as all other causes combined. No other cause of post-mortem rejection was responsible for as much as 15 per cent of the total, among the more important being pneumonia, emaciation, and injuries. In the case of calves, the chief causes for post-mortem condemnation have been immaturity, emaciation, and pneumonia, immaturity accounting for about a third.

By-products of slaughter, condemned animals and parts, and dead or dying animals are not the only sources of grease and tallow in interstate plants. Some of the larger packers operate glue and gelatin departments which yield grease or tallow or neatsfoot oil as by-products. Some of the material used originates outside the packing house, for example, hide trimmings from tanners, and junk bones.

The inedible departments of inspected plants are permitted, under certain strict regulations, to take in for rendering a variety of materials that come from elsewhere than the edible department.¹ These materials evidently yield much more tallow than grease. They consist of dead animals, shop fats, and products from local plants.

¹ Pertinent federal regulations are: ". . . departments used for inedible products shall be maintained in an acceptably clean condition The accumulation upon the premises of establishments of any material in which flies may breed is forbidden. No nuisance shall be allowed in any establishment or on its premises Inedible fats from outside the premises of an official establishment shall not be received except into the tank room provided for inedible products, and then only when their receipt into the tank room produces no unsanitary conditions on the premises. When so received, they shall not enter any room or compartment used for edible products nor, unless permission therefor in advance shall be obtained from the Secretary of Agriculture, shall any dead animal be brought into compartments when inedible products are prepared. 'Dead animal,' within the meaning of this paragraph, shall be construed to include any animal which died without having been inspected under these regulations." (Regulations Governing Meat Inspection, U.S. Dept. of Agriculture, B.A.L., Order 211—Revised, effective Nov. 1, 1922.)

From small establishments are purchased fats of various sorts, raw and rendered; various sorts of offal; also tankage and cracklings which often contain considerable quantities of fat because small plants are not equipped with presses for its expression. Furthermore, animals that have died en route to or in the yards may be rendered if this is not prohibited by local ordinances. All products of this kind, if unfit for edible purposes, must go directly into the inedible department without passing through any section of the plant producing food products. If the products manufactured in the inedible department are of such a character that they cannot easily be distinguished from the corresponding edible products, they are required to be denatured. The manifest purpose of the denaturing requirement is to prevent use for edible purposes after the article has passed into the channels of trade.¹

Under certain conditions shop fats may be taken into the edible departments of inspected packers. This is the case if they are sound and sweet and come from shops handling federally inspected meats only. It is the custom of federal inspectors to stamp with the official inspected-and-passed mark the kidney and pelvic fats of all carcasses so that these, when trimmed off by the retail butcher, remain earmarked. If he keeps them separated without obliterating the inspection mark, they may be brought into the edible departments of inspected houses for the manufacture of edible tallow, provided they are still sound and sweet.

It has been impossible to ascertain how widespread is the practice of bringing shop fats and fats from uninspected houses into inspected ones, or what volumes of

¹ According to information current in the trade, substantial quantities of white hog grease go to the Netherlands where the denaturant is largely removed. It is then refined, deodorized, and stiffened with tallow, the product being known as "Dutch" lard, extensively consumed and exported.

grease and of edible and inedible tallow are produced from fat returned in this way to inspected packing houses. In some cities, directly or through subsidiaries, packers gather a portion of these shop fats, the remainder going to renderers. In most localities all of them go to renderers.¹

LOCAL WHOLESALE PLANTS

The local wholesale plants, all operating outside of federal regulation, are becoming an increasingly important factor. True, about 77 per cent of the *wholesale* meat production remains under federal inspection. Yet cattle and hog slaughter of the local wholesale plants more than doubled between 1914 and 1927, and their output of dressed meat increased by about 1.2 billion pounds to a total of 3.3 billions, equivalent (at the rate of 140 pounds per capita) to the meat supply of nearly 25 million of the domestic population. All this excludes, of course, the large total share of the commercial meat contributed by other groups which are not federally inspected: the retail plants, most of the custom slaughter, and the commercial meats from animals slaughtered by farmers, peddlers, and so forth.

It is in the kill of cattle and swine that the local wholesale plants have grown.² Their kill of cattle rose from 392,000 in 1914 to over 1 million in 1925; and of hogs from 1.9 to 5 million head. The preliminary figures for 1927 show a further increase in unofficial cattle slaughter but a decline in hogs (p. 160). Of calves and sheep the net in-

¹ On the whole, the information obtained by correspondence confirms the statistical evidence that a relatively small proportion of the available outside wastes is handled by packers. This is attributed to a number of reasons, such as the competition of renderers and local or federal restrictions. It is true that the letter of the federal regulations permits this practice, under stated restrictions, and that in several large packing centers considerable use is made of the privilege. In practice, however, we find that the various limitations tend to discourage operations of this sort.

² Of the domestic meat production, however, beef and pork constitute about 90 per cent.

crease since 1914 has been relatively slight. In view of the relatively small proportion of by-product in hog slaughter, an increase in such slaughter by unofficial plants might be expected. It is noteworthy, however, that the rate of increase has been nearly as rapid in cattle as in hogs.

In most respects the operations of the local wholesale slaughterers are essentially similar to those of the interstate plants of corresponding size. The main differences are those which result from the disparity in the breadth of market and from the handling of by-product. Unofficial plants must dispose of all their edible products within the state, or even within a more limited territory when the local inspection is not recognized by other state or municipal officials. In practice, however, the business of such plants usually centers in a single city or urban district. For the restricted market, however, there are a number of compensations. Local inspection is usually much less effective than that of the federal government; indeed, in many localities local regulation is practically negligible.¹ In consequence, unofficial plants often enjoy greater freedom from restrictions which add to costs; their capital investment per unit of output is less; they are relatively unrestricted in regard to adulteration and misbranding; and they suffer fewer losses from condemnation. In practice, adequate sanitation and drainage have been found to be as important as competent ante-mortem and post-mortem examination of meat animals. Few unofficial plants could obtain federal inspection without radical changes in buildings and equipment. Then, too, tuberculosis (bovine) is more common in dairy cattle and in hogs and poultry subject to infection from such cattle. Dairy cattle, as well as hogs subject to contagion therefrom, constitute a larger proportion of the receipts of the local plants, especially of the retailers.

¹ When there is effective local inspection the same limitations apply as in interstate plants, since the federal regulations set the standard.

Veal calves, most of which are slaughtered in local plants, and sheep are relatively free from tuberculosis.

It is, of course, quite impossible even to hazard a guess as to how their rejections on account of disease or other causes compare in volume with those of inspected houses. They must differ greatly with different concerns, with the character of the local inspection, and with the business standards of individuals. Very probably the conditions described to Congress¹ as prevailing in some of the great packing centers during the 1880's, when dead and sick hogs were freely rendered for lard, no longer prevail anywhere. Nevertheless, we cannot go far astray if we assume that as a whole the losses by local packers from condemnations and sanitary restrictions are less than those of interstate concerns. It is noteworthy that, while interstate operators as a class recognize the advantages of the federal inspection service, individual operators informally state that the federal regulations are in several respects unnecessarily severe; for example, in regard to the condemnation of hog heads because of the presence of enlarged glands, the requirements as to thorough dehairing and cleansing, and the removal of teeth, ear drums, and turbinated bones.² Such men, if they operated without inspection, would very probably make food products out of such heads and neglect the other sanitary precautions. Doubtless their opinion is shared by not a few who actually operate without federal inspection, and is acted on if local inspection permits. The statement is made by managers of interstate plants and others, and specific instances cited, that shippers and commission merchants tend to divert to unofficial plants the reactors and other

¹ "Compound Lard: Statement of W. G. Bartle before the House Committee on Agriculture of the Fiftieth Congress," *House Reports*, Vol. 3, No. 970, Part 2, April 14, 1890, p. 19 (51st Congress, First Session, Serial No. 2809).

² These are, of course, merely the views of laymen. Only physicians and veterinarians are competent to pass judgment on questions of this kind. Moreover, to a layman it would appear that where doubt exists, the public welfare should have the benefit of it in the more severe policy.

meat animals of doubtful soundness; also animals from areas which yield a relatively high proportion of condemnations, and therefore are bid in at lower prices. The prevalence of hog cholera, for example, is regarded as one reason for the growth in local hog slaughter. Interstate slaughterers regard such practices as a form of unfair competition. How much credence should be given to these statements or how extensive the practice may be, it is impossible to say.

Of course the views of competitors need to be discounted. Interstate packers and affiliated interests cannot be expected to regard with equanimity the growth of local competitors, comparatively free of the close supervision and sanitary restrictions incident to federal regulation. Doubtless there are many sanitary and efficient local plants, operating under fairly competent state or municipal regulation. However, in our correspondence with qualified and impartial observers in different sections of the country, with few exceptions the conditions of local slaughter and inspection are stated to be far below the federal standard.

In respect to by-products, the position of the local plants appears to be improving somewhat. Within recent years there has been an increase in the consumption of such edible offals as liver, kidneys, sweetbreads, brains, and the like. Often there is a ready local market for casings, bladders, and bones. Part of the surplus meat, trimmings, and edible by-product is sold to local sausage kitchens and other processers of meat specialties, or worked up by the slaughterer into such products as scrapple, headcheese, and sausage of various kinds. These are products that are largely of local manufacture and sale, the production of which has greatly increased until it is now well over a billion pounds.¹ Nevertheless, the

¹ In wholesale slaughtering and meat-packing plants alone, the production of sausage, meat puddings, headcheese, scrapple, and so forth, was over a bil-

local plant remains with a relatively large proportion of edible by-product that must be rendered for commercial fat or sold to producers of industrial products (glue, bone char, feed, fertilizer, and so forth) where such a market is locally available. Now the situation with respect to edible hog and beef fats is quite different.

The unofficial plant is limited in its outlets for lard by the absorptive capacity of the local market. Apparently there is nearly always some sort of a market for local or butchers' lard at a price, a price sometimes scarcely higher than that of white grease. Such lard must be sold in competition with the nationally advertised brands of the large packers, and with vegetable shortenings and lard substitutes. Part of the local product goes to the household trade. Bakers and other wholesale consumers seem to be able to absorb large quantities if prices are attractive. Bakers of bread, biscuits, and similar articles utilize over 360 million pounds of lard and other shortenings. There is no regulation to prevent the use of shortening from uninspected plants even in those baked goods that pass into interstate commerce. What cannot be disposed of in these various ways must be turned into grease or sold raw (unrendered) to renderers or to producers of industrial derivatives.

The biennial census of manufactures reports the total grease output of wholesale slaughterers and meat packers, and the Department of Agriculture that of the federally inspected plants. The difference between the two figures should represent the grease output of wholesale plants not subject to federal inspection. The data for 1925 and 1927 are given on the opposite page.

lion pounds in 1927 (census). In addition, large quantities are made in retail establishments and meat shops in nearly every city. There is a further substantial production in plants not classified in the census as "slaughtering and meat-packing." Under federal inspection alone the amount of "sausage chopped" was 777,605,892 pounds (fiscal year 1927-28).

PRODUCTION BY MEAT PACKERS

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	1925	1927
Grease production (million pounds)		
All meat packers ^a	179.8	182.3
Interstate plants ^a	125.3	124.3
	<hr/>	<hr/>
Balance—local wholesale plants.....	54.5	58.0
Average per hog, in local wholesale plants (pounds)^b	10.9	15.3

^a See Table 7, p. 107.

^b Computed with the aid of data in Table 10, p. 129.

So calculated, the average yield of grease per hog slaughtered in local wholesale plants is very high—between three and five times that in the official establishments, as shown in Table 9, p. 118. These figures suggest that a considerable proportion of edible hog fat in unofficial plants goes to white grease instead of to lard. This is to be expected in view of the limitations upon their market for lard. The official data on lard production (which, however, are none too reliable), as given below, tend to bear out this inference:

	1925	1927
Lard production (million pounds)		
Total ^a	1,552	1,656
Interstate plants ^b	1,452	1,557
	<hr/>	<hr/>
Balance—local wholesale plants.....	100	99
Lard per hog (pounds)		
In interstate plants ^b	33.8	35.8
In local wholesale plants ^c	20.0	26.0

^a From *Animal and Vegetable Fats and Oils*, Bureau of the Census.

^b From *Crops and Markets*, March 1926, p. 90, and March 1928, p. 87.

^c Obtained by dividing lard output of local wholesale plants (as shown above) by the hog slaughter of such plants (see Table 12, p. 159).

Although these data, collated from independent sources, point to the same conclusion, they cannot be unreservedly accepted. Both the statistics for total lard and federally inspected or interstate lard contain duplica-

tions; the former, because the large packers buy unrefined lard and reprocess it, and the federally inspected lard because it represents "inspected" pounds. The same lard may be inspected more than once. It is not possible to determine to what extent these are offsetting duplications.¹ Unfortunately, most of the statistical data for the animal industries are inadequate.

That unofficial plants have virtually no outlet for edible beef and mutton fat, as such, has already been explained. There are no data which permit one to get even a rough approximation of the total volume of edible by-products from the wholesale and retail kill not subject to federal inspection. We can apply the yields in the interstate plants to the local wholesale slaughter of 1925 and to the retail slaughter of 1909 with results as shown in the following figures, in million pounds:²

Edible product	Local Wholesale, 1925	Retail, 1909	Sum
Cattle fat.....	35.0	140.0	175.0
Cattle offal.....	28.0	115.0	143.0
Calf fat.....	0.5	4.0	4.5
Calf offal.....	2.6	19.0	21.6
Sheep fat.....	3.4	4.2	7.6
Sheep offal.....	3.2	3.9	7.1
Total	72.7	286.1	358.8

Upon this basis, the total amount of edible offal and edible fat, from cattle, calves, and sheep, for which such local plants must find a market is 358 million pounds, more or less. This assumes that the retail slaughter has

¹ Two divisions of the Bureau of the Census report a different total for lard, probably because one, the census of manufactures, permits packers to report by fiscal years. The quoted data for federal inspection and total lard are for calendar years.

² For source, see Table 10, p. 129.

remained at the level of nearly two decades ago. It will be observed that the great bulk of the edible by-product consists of cattle fat and offals. If the retail kill of cattle has increased at the rate of the local wholesale slaughter, the figure should be nearly trebled.

In local plants the volume of raw material for tallow (edible and inedible) and tankage, per head of slaughtered animals, must be different from that secured in interstate plants because of the different outlets in the two types of plants for trimmings and offal.¹ Interstate plants have a good outlet for these materials in canned products, extracts, and other meat specialties as well as oleo and edible tallow, which is denied local plants. On the other hand, the latter have an advantage in marketing sausage and similar meat products, being less restricted in processes and ingredients than interstate packers. Yet

¹ Representative yields, in pounds per animal, for cattle and calves, when head, feet, entrails, and all fats are "tanked" for inedible tallow, and for hogs, when all lard fat is saved and only inedible materials go to the tank, are as follows (as stated by *The National Provisioner*, July 21, 1928, LXXIX, 28, responding to a query from a small plant):

	Cattle	Calves	Hogs
Tallow	34	2	...
Grease .....	..	.	2.3
Cracklings	34	9	4
Blood	7	2	1.5

These figures are approximate. Actual yields vary considerably, according to type and condition of the animal, and slaughterhouse practice. For cattle the reported yield of cracklings (34 pounds) appears to be too low. A yield of 50 pounds would be more representative in view of the tallow yield of 34 pounds.

Representative of the practice of interstate plants are the following yields of inedible product, obtained by the wet method of rendering, in pounds per animal, given by the same source (correspondence):

	Cattle	Calves	Sheep
Prime tallow	4.41	...	...
No. 1 tallow .....	...	.45	.19
No. 2 tallow .....	.95	...	.28
Brown grease	1.23	.65	.19
Concentrated tankage	5.80	Not given	.60
Regular tankage	9.25	Not given	.90

Yield of concentrated tankage, from hogs, is given as 2.35 pounds per head, and of regular tankage 3.60 pounds.

there are limitations upon this outlet for fats. Where beef is used a lean meat is mainly required, tallow giving the product an objectionable flavor; and an excess of fat impairs the quality of sausage, causing it to shrink or "fry out" in cooking. Much of the demand is for pork sausage; and the demand is seasonal. The production of canned sausage, which helps interstate producers in marketing because it makes storage feasible, is not practicable for local packers. Sometimes tallow is used in shortenings manufactured for the local trade, and a little is sold to some classes of the population which prefer beef suet to commercial shortening. If there is a good market for lard, considerable quantities may be worked off by adulterating lard with tallow. What cannot be used in this way must be disposed of as inedible tallow, or the surplus raw fats sold to renderers. The situation is complex. The relatively large increase in the output of inedible tallow is nevertheless significant as to this mode of utilization (see pp. 99-115).

It is obvious then that there are two factors that hamper the full utilization of by-product fats in local plants. One is the restrictions imposed by the federal Meat Inspection Act; the other is the small size of many of the plants which makes the full utilization of by-products uneconomical. As a result of this situation, many small slaughterers do not trouble to work up edible by-products at all, except for the lard their trade will absorb, but sell the unrendered materials either to renderers or to large interstate packers who take them into their inedible departments. In any event, they go to inedible uses.

Recently in certain localities co-operative or quasi-co-operative concerns have sprung up for the better utilization of the by-products from several slaughterers, each of whom is too small for efficient operation.¹ Thus a

¹Such co-operative processing of butchers' offal is by no means new. Campbell Morfit, in *Chemistry Applied to the Manufacture of Soap and Candles*,

sufficient volume is obtained to make the utilization of by-products feasible. This scheme is worthy of further extension, though no doubt it will be hampered by inability to ship in interstate or foreign commerce.¹

In general, the local slaughterers center in the "butcher towns" of the large cities, and supply an increasing proportion of the local demand for fresh meats. Their outlets for edible by-products, however, are limited. The national packers, partly dispossessed of this local fresh-meat trade, supply more of the cured and prepared meats. Besides, through their refrigerator car routes, distributive and credit machinery, and diversified products, they control much of the business of the smaller cities and towns within and across state lines, as well as the entire export trade. Yet the development of motor truck routes is enabling the small wholesaler to compete with the refrigerator cars of the large packers over a wider area. In districts remote from railways and in rural or sparsely populated areas, virtually the entire fresh-meat supply is obtained from local slaughter. The keeping quality of such meat is limited. The comparative importance of fresh and cured meats, in urban and rural communities of different sections of the country, is shown by the following percentages of fresh and cured meats in total meat

published in 1847 (Carey and Holt), makes the following statement (p. 326): "In New York the butchers have an association of their own, and possess a large foundry exclusively for the rendering of tallow; it is here they send their rough suet, and being then credited with the quantity, receive an equivalent share of profit corresponding with the market price of refined tallow."

¹ Very recently a new patented process has come into use in two states, California and Illinois, as well as in Canada. It is reported that animal fats of a variety of sorts, whether from federally inspected establishments or not, are mixed with crude cottonseed oil, the mixture being then subjected to the regular processes of refining, deodorizing, and decolorizing to which cottonseed oil is customarily subjected when refined for edible uses. Thus a shortening of the lard-compound type is produced which is sold within the limits of the state of production only. At present the volume of this product is not large. A primary advantage of this process is that it makes possible the production of a fairly good shortening from inferior and low-priced animal fat.

consumption, based upon reports secured from about 13,000 families in 1918:¹

Meats	North		South		West	
	Urban	Rural	Urban	Rural	Urban	Rural
Fresh	77	43	56	21	82	51
Cured	23	57	44	79	18	49

It will be observed that in 1917, the year to which these figures refer, the rural areas used a smaller proportion of fresh meat than the urban areas. It may be presumed that with the development of motor transport the difference has become less pronounced.

It is noteworthy that hog products—hams, bacon, smoked pork, and the like—comprise the great bulk of the cured or processed carcass meat. For the wholesale meat-packing industry the census of 1927 reports the total dressed weight of the different classes of stock, as well as the production of fresh and cured meats. From this report it seems that virtually all of the carcass meat of sheep and calves is sold fresh; and so also is about 95 per cent of the beef. On the other hand, the production of fresh pork is only about 38 per cent of the dressed weight of hogs. Moreover, a good deal of this output of fresh pork, with a smaller proportion of carcass beef, goes to canners, sausage makers, curers, and so forth.

RETAIL BUTCHERS

Much of what has been stated above with respect to local wholesale plants applies with even more force to the retail slaughterer whose volume of operation and market are of course more limited, and whose operations are usually exempt from regulation. Retail slaughterers

¹ U.S. Department of Agriculture Bulletin 1317, June 1925, p. 39.

or local butchers, of whom there are large numbers, are usually located in the smaller cities and towns. They cater to the retail trade of the immediate locality, operating a meat market or grocery (or a small chain) in conjunction with a small slaughtering establishment. The two are of course geographically separate. Should such a producer enter into the wholesale trade he would become subject to such regulations as are provided by the county, city, or state for wholesale slaughter. Since adequate inspection involves ante-mortem and post-mortem examination, with inspection of the viscera, an inspector must be present at the time of slaughter. Obviously, the inspection by a competent official of the small kill of such a plant, often in a remote section, is relatively costly; when attempted, arrangements are made for slaughter on stated days and at certain hours. Inspection is sometimes post mortem, with the requirement that pending inspection the carcass shall be retained "with the head and all viscera other than stomach, bladders, and intestines held by the natural attachments." It should be noted that the federal Meat Inspection Act, which sets the standard, gives a qualified exemption in interstate trade to retail butchers and dealers supplying their own customers (see p. 16). In 1928 about 26,000 carcasses and 5.4 million pounds of meats (chiefly veal and beef) were so shipped. This doubtless is only a fraction of the amount that is sold within the states and is thus beyond federal jurisdiction.

Another class of retail slaughter is that of the professional meat peddlers, who, with farmer-peddlers, are important factors in the trade of many localities. Commercial peddlers usually operate during the entire year, but are more active in the summer, especially in the Northeast. They are common in oil fields, mining regions, and similar territory where the population is fairly dense but too scattered for the successful operation of retail mar-

kets. Often they are the only source from which residents of the country and small villages can procure fresh meat. The commercial peddler usually purchases and slaughters animals wherever he finds them, and retails the meat the next day on his route. While there are many conscientious and reliable dealers of this kind, there is yet likelihood that such peddlers will slaughter animals that are in poor or even diseased condition. Animals are slaughtered under crude farm conditions, beneath a tree or in a barn. While this is often unsanitary, it is preferable to slaughtering in a poorly equipped slaughterhouse with danger from decaying offal.¹

The aggregate volume of retail slaughter reported by the census of 1909 (the only one made) was about twice as great as that of the local wholesale plants, and about a third of that of the federally inspected plants. Whether it has increased more or less rapidly than wholesale slaughter it is impossible to say. There are no later statistics, and the opinions of the trade differ widely. Some say retail slaughter has declined, yet in some areas wholesale slaughterers complain of the growing competition of peddlers and retail slaughterers. Doubtless these represent local variations. Probably retail slaughter has declined in the more densely populated regions; but whether this has been offset by an increase in the oil and mining regions, and in the South, is mere conjecture. Country standards of fresh meat are rising above the grade of product of the traditional meat peddler.

Upon the fat output of the retail slaughter there are no data. Probably all of the by-product that cannot be disposed of locally is sold to renderers or fed to hogs. As stated before, the annual report of the census of fats and oils explicitly states that "the figures of production do not include those considerable quantities of lard, tallow, and

¹ Marshall, *op. cit.*, p. 42.

grease produced in the households, on the farms, and by the smaller local butcheries and meat markets."¹ Perhaps this accounts for the fact that the census statistics of consumption of inedible tallow exceed production (after allowing for imports and exports) by about 100 million pounds.²

FARM SLAUGHTER

How much of the product of the large farm slaughter goes into commercial channels is not known. According to the investigation of retail marketing of meats already quoted (pp. 15-16), lack of a convenient market and the desire to obtain a larger return for livestock frequently lead farmers to dispose of it by this method. Peddling of meats by farmers is chiefly confined to the fall and winter, when it doubtless enables a fuller employment of farm labor during the slack season. Usually farmers slaughter their own livestock. A class known as butcher-farmers sometimes purchases stock from neighbors. Most urban communities do not assess the farmer-peddler with the usual tax or license fee. In some states incorporated communities are forbidden by state law to assess farmers with such taxes.

It seems to be the general view that the amount of fat, both edible and inedible, that finds its way into commerce from this source is relatively small. Equally obscure is the situation with respect to farm- or country-cured meats

¹ U.S. Bureau of the Census, *Animal and Vegetable Fats and Oils, Calendar Years 1925 and 1926*, p. 2.

² It may be that grease is loosely reported as tallow by some consumers; but the data for grease, after consideration of exports, production of derivatives, and consumption, do not indicate a corresponding surplus; indeed, a discrepancy of a smaller character is indicated (see p. 327). Some edible tallow of inferior grade may be reported as being used for industrial use; or again, grease may be melted with and reported as tallow. The last seems hardly likely to affect the figures of production, since if practiced by producers the product would be reported in the form of the final mixture, tallow or grease.

and lard, although in certain localities a fairly large trade of this sort is believed to exist. A few million pounds of farm meats and lard go into interstate trade, under special arrangements provided therefor by the Meat Inspection Act. In the fiscal year 1927-28 such interstate shipments of farm meats and lard were 6,720,801 pounds and 77,361 carcasses. The main item is veal. As in the case of retail slaughter, such interstate shipments are doubtless a small fraction of the total that moves into the intrastate trade.

CUSTOM SLAUGHTER

Custom slaughtering closely resembles a like practice in flour milling, known as custom flour milling. A farmer brings grain to a mill, receives the derived flour or meal, and leaves the by-product feed in payment. Similarly, when an abattoir kills and dresses livestock for the account of other establishments or persons owning the stock, the practice is known as custom slaughtering. In compensation the abattoir sometimes retains the hide or offal in lieu of the custom toll. Usually there is a straight charge with a credit for offal.

The analogy extends farther. The great bulk of the flour milling is done in merchant (wholesale) mills which buy their grain and sell the derived products. The bulk of the slaughtering business is done by wholesale slaughterers who buy livestock outright and sell meats and allied products. Both industries include plants which engage in a more or less incidental custom business. Both also include plants which are mainly or exclusively engaged in the custom business: in the one, these are called custom mills or gristmills; in the other, they are termed custom slaughterers. The resemblance extends even to the relative magnitude of the two types of operation. Of the combined value of product of custom and merchant

mills, the former produced in 1919 about 4.4 per cent. In the same year, 4.9 per cent each of the beeves and swine received in the wholesale slaughtering industry were slaughtered on a custom basis. Other classes of stock are relatively unimportant, in respect to meat yield. Data for later years are not reported.

The conditions of custom slaughtering are varied and complex. Considerations of economy or quality sometimes induce butchers and meat markets to buy livestock and have the meats dressed on a custom basis. A varying proportion of their raw material is similarly obtained by wholesale provisioners, sausage makers, and other processors and curers of meats. Not infrequently, also, farmers elect this method of having their livestock slaughtered and then peddling the meats, selling at retail or wholesale. Co-operative and municipal abattoirs fall into the class of custom slaughterers. The extent of custom work depends somewhat upon local regulation, its stringency with respect to the sale of farm-killed meats, and upon whether it requires the concentration of local slaughter in such abattoirs. In New Orleans, for example, all slaughtering is concentrated in two establishments. One is a co-operative, under municipal inspection. The second, under federal inspection, is quasi-co-operative, combining joint stock ownership with straight custom work. It is interstate mainly in that some of the patrons sell provisions to the vessel trade.

There are, as noted above, two classes of custom slaughterers: wholesale slaughterers who do an incidental custom business, and plants which are almost exclusively engaged in such custom work, the "custom slaughterers" proper. The second class operates along co-operative lines. In each class are plants which operate under federal inspection and plants under local regulation, but the character of the business of their patrons indicates that

the bulk of the "custom slaughterers" are under local regulation. Both classes include patrons who are in the wholesale or in the retail meat business.

The total slaughter on a custom basis numbered 4.3 million head in 1914 (equal to the local wholesale slaughter) and only 3.5 million head in 1919, distributed as follows:¹

	1914	1919
By wholesale plants.....	2.1	2.2
By abattoirs doing custom slaughtering exclusively	2.2	1.3

In both years, however, the meat yield was around 700 million pounds, basing the estimate upon yields reported by wholesale plants. A decline of nearly 600,000 and 525,000 head in the hog and sheep kill, respectively, was virtually offset in meat yield by a rise of 176,000 in the cattle slaughter.

The amount received by wholesale slaughterers for custom and contract work has increased notably. In 1914, it was \$278,000; in 1919, \$1,979,000; in 1921, \$944,000; and in 1925 and 1927, it was about \$2,500,000. Part of this substantial increase may represent merely a rise in the custom charge. Evidently, however, custom slaughter has grown.

The census data for establishments engaged in custom slaughtering only are reported as follows:

	1909	1914	1919
Number of establishments	31	33	33
Number of wage earners.....	433	553	825
	(Thousand dollars)		
Capital	1,196	1,540	2,471
Salaries and wages	276	387	991
Cost of materials.....	137	452	869
Value of products.....	653	1,158	2,375

¹ Based in part on statement in the *Census of 1920*, X, 52. The data cited below do not support the Census Bureau's inference that the number of establishments doing custom killing exclusively is declining.

A progressive expansion will be observed in number of wage earners, capital, value of products, and cost of material. These plants are reported to be increasing the amount of rendering and further processing of products. The materials used are those received for the service rendered or purchased from establishments for which the slaughtering is done. The 33 plants of this kind reporting in 1919 were dispersed over more than a score of states: 23 of these plants were operating under corporate ownership, 8 were owned by individuals or partnerships, and 1 was a municipal plant.

So far as concerns utilization of by-products and the production of animal fats, conditions of custom slaughtering appear to be substantially those of the wholesale plants. Where custom work is done under federal inspection, manifestly the conditions are those described for the interstate wholesale plants. Mostly they fall under state or local regulation and are subject to the conditions and limitations of the "local wholesale" plants. In the smaller municipalities, custom or co-operative abattoirs may offer at least a partial solution to the problem of meat inspection.

We have gone at considerable length, and with some repetition, into the various aspects of regulation of slaughter of animals, because the supplies and prices of the inedible fats and oils are entrained with the supplies and prices of fresh meats and cured meat products. The entire industry of raising, slaughtering, and marketing domesticated animals is a huge joint-product operation; one group of the products, the inedible fats and oils, is the topic of this study, and the relations of this large, if minor, group of products are not to be understood and evaluated without consideration of all the products and relations. These many seemingly rather distant circumstances in the broad field are still closely germane to the subject of the inedible fats and oils.

CHAPTER VIII

TREND OF SLAUGHTER AND MEAT PRODUCTION UNDER FEDERAL AND LOCAL REGULATION

BASES OF OFFICIAL ESTIMATES

The facts cited in the previous chapter obviously have an important bearing upon many aspects of the domestic food supply. It is difficult adequately to appraise their significance without a comparison of the volume and trend of slaughter and meat production under federal and local regulation, respectively. These matters are of public interest aside from their relation to the production of fats. They present, also, problems of trade policy that are of serious moment. Unfortunately, however, our information on these subjects is defective. Hence it is necessary to turn aside from our main subject to give something more than a cursory examination of the available data.

There are two steps in the statistical process of determining slaughter and meat production. The first step is to ascertain the slaughter of the different classes of livestock and the proportion of each that comes under federal and local regulation. These are quantities and proportions that must vary from year to year. Next, it is necessary to arrive at the average annual yield of meat from each class of livestock in order to translate slaughter into terms of meat production. The average dressed weight per head ranges from slightly less than 40 pounds for sheep and lambs to over 500 pounds for cattle.¹ A different coefficient of yield must be applied

¹ The weight of the carcass, dressed, affords a reasonably close approximation of the yield of carcass meat. However, after the process of dividing

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each year, since the average varies according to conditions of range and pastures, availability and prices of feed, and prices of livestock. A different coefficient of yield must also be applied to the kill in different classes of establishments. A heavier type of animal goes to the large interstate than to the smaller interstate and local wholesale plants; this is shown by the average live weights, in pounds, reported for the calendar year 1916:¹

Animal	"Big Five"	All other interstate	Local wholesale
Cattle	1,003.6	994.2	946.2
Calves	181.3	154.2	149.3
Sheep	79.2	77.9	78.8
Swine	215.2	196.4	160.9

Still lighter animals, on the average, go to the retail slaughterers, who handle a relatively large proportion of thin stock and immature veal calves. The yields from farm-killed animals must be different. The ultimate figures must be expressed in terms of meat; but, in view of the millions of animals slaughtered, it is evident that unless appropriate allowance is made for such variations as the foregoing the final data may be far from depicting the actual volume of production.

So numerous and substantial are the variable factors that it appears idle to attempt estimates without a considerable background of factual data, periodically rechecked for changes in the trends.

the carcass, and of chilling or freezing, curing, canning, and so forth, the actual yield of meat as sold by packers may differ considerably from dressed weight. In addition to the carcass meat, there is a large volume of edible by-product, such as head meats, viscera, and the like. Although probably not more than 5 to 10 per cent of the weight dressed, such by-product represents probably a billion pounds of meat, more or less. Current estimates do not include this substantial item in the meat supply.

¹ *Extent and Growth of Power of the Five Packers in Meat and Other Industries* (Report of the Federal Trade Commission on the Meat-Packing Industry, Part 1), June 24, 1919, p. 114.

The tabulation which follows shows the status of the available information respecting slaughter and meat yields in different classes of establishments and in differ-

SOURCES AND LIMITATIONS OF BASIC DATA UPON SLAUGHTER AND MEAT PRODUCTION, 1899-1928

Class	Number of animals slaughtered of the different classes	Meat production
Wholesale slaughter Total	Census of 1899, 1904, 1914, 1919, 1921, and biennially thereafter	Dressed weight reported by census, for years corresponding to the slaughter data. No data upon edible by-products
Federally inspected 1907-20	Annual reports of the Meat Inspection Service	Annual data given for dressed weight, in incomplete form
1921-	Monthly and annual reports issued through Bureau of Agricultural Economics	Monthly and annual data given for dressed weight and edible of-fal on basis of returns by most of the large plants
Retail slaughter	Census of 1909; no prior or subsequent reports	No report
Custom slaughter	Census of 1914 and 1919; no prior or subsequent report	No report
Farm slaughter	Agricultural census of 1909 and 1919*	No report

* Cattle and calves combined in agricultural census of 1919. Since the meat yield from cattle is about five times that from calves, this defeats a computation of meat yield and affects the comparability of the data.

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ent years, according to census enumerations, reports of the federal Meat Inspection Service, and the estimates used by the editorial office of the Bureau of Animal Industry.

SLAUGHTER

A complete census of slaughter has never been made. The decennial census of 1910 (as of 1909) is the most nearly complete, for in that year, and in that year only, a special census was taken of the large retail slaughter in butcher shops and meat markets. In addition, an enumeration was made of the kill on farms and in wholesale establishments. We have, besides, the annual report of the federal Meat Inspection Service for the slaughter in the federally inspected plants, i.e., the wholesale plants engaged in interstate commerce. These make possible an approximation of total slaughter in 1909, as well as of the relative magnitude of interstate and local slaughter in that year. By deducting the federally inspected from the total slaughter we obtain the kill not subject to such inspection; and by deducting the same figures from the wholesale slaughter we obtain the "local wholesale." Table 11 (p. 158) gives the status of slaughter in that year, nearly two decades ago. This census as of 1909 is especially important; although made two decades ago, it is the only year for which we have a reasonably complete picture of the situation. It furnished the base, also, for the earlier estimates of total and non-federally inspected slaughter, as well as of the total kill.

Even the census of 1909 is incomplete, for it made no report for the custom kill. If the latter was as large as in 1914 and 1919, when it was reported, it constituted less than 5 per cent of the total (see Table 12, p. 159). Without allowing for the unreported custom kill, the total slaughter in 1909 numbered 88.4 million head, of which

the proportion of the interstate plants was 59.6 per cent, or 52.7 million animals. The remainder is the kill outside of federal inspection, aggregating 35.6 million animals. The farm slaughter, 18.6 million, is entirely uninspected; the retail kill, uninspected or under some measure of local

TABLE 11.—ANIMALS SLAUGHTERED FOR FOOD, CALENDAR YEAR 1909*
(*Thousand head*)

Slaughter	Total	Cattle	Calves	Sheep and lambs	Swine
Interstate wholesale.....	52,741	7,714	2,189	11,342	31,395
Local wholesale.....	4,038	401	316	914	2,476
Total wholesale.....	56,779	8,115	2,505	12,256	33,871
Retail.....	13,013	4,088	2,880	1,940	3,970
Farm.....	18,567	1,409	1,132	530	15,379
Grand total.....	88,359	13,612	6,517	14,726	53,220

* Data from *Census of 1910*, X, 344, Table 21, supplemented by interstate inspections from U.S. Bureau of Animal Industry, *Meat Production, Consumption, and Foreign Trade in United States, Calendar Years 1900-1927*; number federally uninspected (local wholesale) computed by deducting federally inspected slaughter from the total wholesale slaughter reported in the census. As explained in the text, the data above are incomplete because the census did not include custom slaughter, which in 1914 was 4.3 million head.

regulation, was 13 million; and the local wholesale under a varying local inspection was 4 million. Arrayed by classes of stock, the federally inspected plants received 33.6 per cent of the calves, 56.7 per cent of the cattle, 59 per cent of the swine, and 77 per cent of the sheep and lambs.

For later years there are no trustworthy comprehensive data. Census enumerations are reproduced in Table 12. These relate almost exclusively to total wholesale slaughter, which we have apportioned to interstate and local plants according to the reports of federal inspection. For the census years we have also added the rough annual

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estimate of total slaughter of the respective classes of stock issued by the Bureau of Animal Industry. By deducting wholesale slaughter as reported in the census from this estimated total slaughter we obtain a residual

TABLE 12.—MEAT ANIMALS SLAUGHTERED, CENSUS YEARS 1909-27*
(Thousand animals)

Class	Census year	Wholesale			Retail	Farm	Retail and farm	Grand total	Custom
		Inter-state	Local ^a	Total					
Cattle	1909.....	7,714	401	8,115	4,068	1,409	5,497	13,612	....
	1914.....	6,757	392	7,149	....	....	3,855 ^a	11,004	378
	1919.....	10,001	728	10,819	....	....^b	4,019 ^a	14,838	554
	1921.....	7,608	656	8,264	....	....	4,007 ^a	12,271	....
	1923.....	9,163	1,015	10,178	....	....	3,705 ^a	13,883	....
	1925.....	9,863	1,001	10,864	....	....	3,852 ^a	14,706	....
1927.....	9,520	1,205	10,725	....	....^c	3,275 ^a	14,000	....
Calves	1909.....	2,189	316	2,505	2,380	1,182	4,012	6,517	....
	1914.....	1,697	322	2,019	....	....	2,642 ^a	4,661	243
	1919.....	3,969	427	4,396	....	....^b	4,049 ^a	8,445	388
	1921.....	3,809	507	4,315	....	....	3,456 ^a	7,771	....
	1923.....	4,500	600	5,100	....	....	3,724 ^a	8,824	....
	1925.....	5,353	423	5,776	....	....	4,323 ^a	10,099	....
1927.....	4,876	601	5,477	....	....^c	3,553 ^a	9,030	....
Sheep and lambs	1909.....	11,342	974	12,256	1,940	580	2,470	14,726	....
	1914.....	14,229	1,715	15,944	....	....	2,346 ^a	18,290	796
	1919.....	12,691	806	13,497	2,385 ^a	435	2,820	16,317	260
	1921.....	13,005	1,763	14,768	....	....	1,942 ^a	16,710	....
	1923.....	11,529	1,665	13,194	....	....	1,668 ^a	14,862	....
	1925.....	12,001	1,615	13,616	....	....	1,838 ^a	15,454	....
1927.....	12,883	1,506	14,389	....	....^c	2,200 ^a	16,589	....

*Data for total wholesale, retail, farm, and custom slaughter from the census; for interstate wholesale and grand total (except 1909), from Bureau of Animal Industry, *Meat Production, Consumption, and Foreign Trade in United States, Calendar Years 1900-1927*; for local wholesale and most of the combined figures for retail and farm slaughter, derived by subtraction. For a critical appraisal of the data, see accompanying text.

^a Derived by subtraction.

^b The census of farm slaughter, 1919, gave a combined figure for cattle and calves of 1,905,000 head.

^c According to unpublished results of a special inquiry upon farm slaughter, made by the federal Division of Livestock and Crop Statistics, in 1927 the farm kill of cattle was 734,000; of calves, 1,026,000; of hogs and pigs, 15,414,000; of sheep and lambs, 532,000 head.

TABLE 12 (Continued)

Class	Census year	Wholesale			Retail	Farm	Retail and farm	Grand total	Custom
		Inter-state	Local ^a	Total					
Swine	1909.....	31,395	2,476	33,871	3,970	15,379	19,349	53,220	....
	1914.....	32,532	1,910	34,442	....	....	21,059 ^c	55,501	2,890
	1919.....	41,812	2,709	44,521	3,869	16,800	20,669	65,190	2,291
	1921.....	38,962	1,745	40,727	....	....	22,230 ^c	62,957	....
	1923.....	53,334	3,684	57,018	....	....	22,825 ^c	79,843	....
	1925.....	43,043	5,030	48,073	....	....	20,221 ^c	68,294	....
	1927.....	43,633	3,859 ^d	47,492	....	....^c	21,758 ^c	69,250	....

^a The contraction, in 1927, in the hog kill of local wholesale plants may be the result of a change in the period covered by the reports. Several of the national packers, operating many plants, changed their reports to a fiscal year ending October 31. The census permits reporting plants to submit schedules for fiscal or calendar years, at their option. The hog run at the end of 1927 was heavy.

figure for farm and retail slaughter combined. The accuracy of this residual figure is obviously conditioned by that of total slaughter, which we shall consider next.

The Bureau of Animal Industry issues an annual statement showing federally inspected, "other," and total slaughter of the different classes of stock and the meat yields. These are the familiar figures generally used (see Appendix, p. 329); but it is not generally realized how far they rest upon insecure foundations. Possessing accurate data upon federal inspections, the Bureau initially assumed that total slaughter bore the same ratio to the federally inspected kill that it did in the base year 1909. In fact, the omission of custom slaughter in 1909, when no data were obtained for it, introduced an error at the base of such calculations. To the extent of this element, the total slaughter and meat production in 1909 were understated, and the proportion of federally inspected slaughter and meat production correspondingly overstated. Data collected for custom slaughter, in 1914 and 1919 only, as shown in Table 12, suggest that the errors

introduced by omission of this item are not of large relative magnitude; but that they have increased progressively may perhaps be inferred from the fact that receipts from custom and contract work increased tenfold between 1914 and 1927.¹

Apart from this point, it is manifest that a process of applying in later years the 1909 ratio of federally inspected to total slaughter could not be expected to yield reliable results. The base year might not be representative in this respect; variations in such ratios probably occur from year to year; and trend changes over a decade or two may be important. It was soon found, indeed, that this statistical procedure yielded a figure for total slaughter that appeared excessive when compared with the current estimates of livestock population.² No fixed ratio of slaughter to livestock population could be assumed. Animal husbandry has been undergoing notable changes; the increasing practice of marketing livestock at earlier ages results in a higher ratio of slaughter, and this may be offset to an unknown extent by a rising proportion of dairy stock. In an effort to secure greater consistency between the figures for slaughter and those for livestock population, the total slaughter was reduced to a more reasonable figure by applying to figures for federally inspected slaughter a much higher ratio than that obtained for 1909. Thus for 1917, 10.3 million cattle were slaugh-

¹ "The statistics for slaughtering and meat packing for 1909 and for 1921 and subsequent years include no data for animals slaughtered on a custom basis. Data for animals slaughtered on a custom basis in 1914 and 1919 are included in footnotes, but not in the tables proper. The figures for all years include, of course, data for receipts for custom slaughtering done by wholesale slaughtering and meat-packing establishments." (From correspondence with the Census Bureau.) In other words, the census data upon total slaughter and meat production are exclusive of custom slaughter; but the toll or fee for such work was included in the data upon value of output.

² Such estimates are subject to a wide margin of error, have been repeatedly revised, and are now undergoing material revision. But the best current estimates of livestock population, issued by another bureau of the Department of Agriculture, could not be ignored in official estimates of slaughter.

tered under federal inspection, and the use of the percentage 56.7 would have yielded a figure of 18.3 million for total slaughter. By assuming that the federally inspected kill was 75.4 per cent of the total, the total cattle slaughter was estimated at 13.7 million instead of 18.3 million.¹ Obviously the data seemed to call for bold treatment.

The adjusted ratios of federally inspected to total slaughter are shown in Appendix Table XIV. A few of the more striking changes are noted in Table 13. It will be

TABLE 13.—ADJUSTED PERCENTAGES OF FEDERALLY INSPECTED TO TOTAL SLAUGHTER*

Year	Cattle	Calves	Sheep and Lambs	Swine
1909.....	56.7	33.6	77.0	59.0
1914.....	61.4	36.4	77.8	58.6
1917.....	75.4	44.7	76.9	59.6
1920.....	62.0	48.0	77.4	61.4
1925.....	67.0	53.0	77.7	63.0
1926.....	68.0	54.0	77.7	61.8
1927.....	68.0	54.0	77.7	63.0
1928.....	68.0	54.0	77.7	65.0

* See Appendix Table XIV for basic data.

observed that the estimates maintain the inspected kill of sheep and lambs at a fairly constant figure; that the percentage for hogs has been varied, although not greatly;

¹ The following comments on the percentages of estimated total slaughter to estimated number of animals on hand at the beginning of the year are pertinent. According to the official estimates, the percentage of slaughter in cattle declined from 22.8 per cent in 1909 to a low of 17.3 in 1915, and gradually rose to 25.3 in 1926, falling to 24.6 in 1927. The percentage of sheep and lamb slaughter rose from 30.4 in 1909 to 48.4 in 1914, and declined to 39.6 in 1927. Hog slaughter in 1909 was 98.3 per cent of the number on hand on January 1, 1909; the percentage rose to a high figure of 131.8 per cent in 1927. The official estimates show an increase in calf slaughter of nearly 50 per cent—from 6.5 million head in 1909 to 9 million in 1927. These changes in the official slaughter ratios are unsupported by any definitive data.

and that wide changes have been made in the percentages for cattle and calves. In the last three years the inspected kill of cattle has been maintained at 68 per cent and of calves at 54,¹ while the percentage of sheep and lambs has been maintained throughout at about 77 per cent. That the relative business of different branches of the packing industry has in fact been as stable as is assumed seems highly improbable. For example, Table 12 shows that in 1919 the non-federally inspected hog kill was estimated as 23.4 million head (total 65.2, inspected 41.8); and the known elements (local wholesale, farm, and custom) aggregated 21.8 million. This leaves 1.6 million head for the retail kill in 1919, compared with 4 million in 1909. There is no evidence to support this indication of so radical a decline. Nor is there any evidence in support of the indicated reduction in the slaughter outside of federal inspection. Indeed, it is certain that the local wholesale slaughter has materially expanded; in the significant items of cattle and hog slaughter it has more than doubled.

Very recently a few supplementary (unpublished) data have become available. These are illuminating. It will be recalled that our figure for local (non-federally inspected) wholesale plants was obtained by subtracting federal inspections from the census enumeration of total wholesale slaughter. If a bias exists in the residual figure,

¹ Owing to the increase in the export trade in beef during the war and the heavy purchases for the war forces and for relief purposes (not included in the exports) there is some warrant for the assumed relative increase in the inspected kill. Such meats must largely have come from the interstate plants. But without doubt the local plants also greatly expanded their operations. Furthermore, the increase in exports of pork was far larger than that of beef; yet the proportion of inspected hog slaughter has not been greatly varied. The increase in pork exports between 1909 and 1919 was 1.4 billion pounds, equivalent to an increase in the inspected kill of about 9 million hogs. From Table 12 it will be observed that the increase in the interstate kill was in fact 10.5 million, which leaves relatively little for the consumption of the war forces, the shipments for relief, and the like. In other words, the local plants must have greatly increased their slaughter.

it is in the direction of understatement. It is noteworthy, also, that the trade seems to feel that the census mailing list is not complete. Now it appears that non-federally inspected packers, no less than the interstate concerns, are subject to and must report in conformity with the Packers' and Stockyards Administration Act when such plants buy animals from public stockyards or animals that have moved interstate. In 1927 the number of such reporting (non-federally inspected) concerns was 215, and their total slaughter is compared below with the aggregate of the local wholesale concerns, as given in Table 12 (in thousands of animals):¹

Item	Cattle	Calves	Hogs	Sheep
All local wholesale plants.....	1,205	601	3,859	1,506
Local wholesale plants reporting (215 concerns).....	751	432	2,494	880
<i>Purchases of the 215 concerns</i>				
From public stockyards.....	463	258	1,856	270
From country direct.....	260	147	674	620

Since many of the local wholesale concerns buy animals locally or within the state, it seems apparent that the figure in Table 12 is a conservative one.

Something can be added, also, with respect to farm slaughter. The Division of Crop and Livestock Estimates of the Department of Agriculture has been steadily amplifying and improving the livestock statistics, some of which have been among the least satisfactory of the official data. An attempt was made to bridge the gap in farm slaughter, and an estimate has been made for the year 1927, upon the basis of reports from a large number of correspondents throughout the country. This report is compared

¹ Thanks are due to the Division of Packers and Stockyards of the Department of Agriculture for furnishing these data.

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below with that of the census of 1909 (farm slaughter, in thousands of animals):¹

Source	Cattle	Calves	Hogs	Sheep
Census of 1909.....	1,409	1,132	15,379	530
Agriculture, 1927	734	1,026	15,414*	532

* Hogs, weighing over 150 pounds, constituted 82 per cent of this item, and pigs, weighing under 150 pounds, 18 per cent.

It will be observed that, except in the case of cattle, the farm kill of 1927 was substantially at the same level as in 1909.

To conclude: In the absence of definite measures of the changes since 1909, the current estimates upon total slaughter must be regarded as approximations of the roughest sort, since the estimates of the kill not now subject to federal inspection appear to be subject to a very large margin of error. The character of these data upon slaughter should be borne in mind in connection with the figures for meat production and consumption, which are based thereon. In estimating meat yields it was necessary to introduce a further series of approximations.

MEAT PRODUCTION

To ascertain, from the material now available, the total production of meats or the production outside of federal inspection seems almost hopeless. The different classes of slaughterers do not receive the same types of meat animals. The dressing percentage and the meat yield from the growing proportion of dairy and dual-purpose animals differs considerably from that of beef animals, and there are no definitive measures of the effect, since 1909, of changing agricultural practice upon meat yields. Only for the wholesale plants, biennially, are

¹ Data kindly furnished by the Division of Crop and Livestock Estimates.

data upon meat production available. For a portion of this wholesale slaughter—that of the interstate plants—annual and monthly figures are reported. The rest is conjecture. It should be noted, furthermore, that the meat production represents the weight of the carcass, dressed. The actual yield of meats chilled, frozen, cured, canned, and so forth, may be substantially different; and no account is taken of edible offals, which must represent around a billion pounds of meat, more or less. Meat production, therefore, in the statistics quoted, refers to the dressed weight.

The data for the basic year 1909 are given in Table 14.

TABLE 14.—COMMERCIAL MEAT PRODUCTION IN 1909, UNDER AND OUTSIDE OF FEDERAL INSPECTION*

Distribution	In wholesale establishments	In retail establishments, meat markets, etc. ^a	Total of "commercial" meat
<i>Million pounds, dressed weight</i>			
Federally inspected ^b	8,402	.....	8,402
Not federally inspected..	1,969	3,219	5,188 ^c
Total	10,371	3,219	13,590 ^c
<i>Percentages</i>			
Federally inspected	61.8	....	61.8
Not federally inspected..	14.5	23.7	38.2 ^c
Total	76.3	23.7	100.0

* Data on wholesale and retail meat production based upon *Census of 1910*, and upon federal inspection from Bureau of Animal Industry, *Meat Production, Consumption, and Foreign Trade in United States, Calendar Years 1900-1927*; meats "not federally inspected" obtained by subtraction.

^a For the retail establishments the census reported only the number of animals slaughtered; dressed weight has here been calculated upon the basis of the yield in wholesale plants.

^b The report of the federal Meat Inspection Service covers "inspected pounds" and probably contains duplications arising from re-inspection.

^c "Commercial" meat, as well as the total and proportion of meat not federally inspected, is larger than the total here given to the extent of the quantity (unknown) of farm sales of meat, and of the custom kill.

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By deducting the amount of federal inspections¹ from the total wholesale meat production reported in the census, we obtain figures for the "local wholesale" slaughter. In the case of the retail kill, where only the number of animals slaughtered is stated in the official reports, we have calculated the meat yield by applying the yields obtained in the wholesale plants. In the absence of any other meat equivalent, this will serve as a convenient approximation to the truth, though it is probably too high. On this basis about 38.2 per cent of the "commercial" (wholesale and retail) meat production was not federally inspected in 1909. To this should be added the proportion of farm-slaughtered meats sold, for which there are no data; also the yield from the custom slaughter, omitted in 1909. In the plants doing an exclusively custom or co-operative slaughter, the meat production in 1909 was probably 700 million pounds, more or less. There is an additional and perhaps larger incidental custom kill in other plants.

The biennial census presents data on all wholesale meat production,² and these data, together with those of the Bureau of Animal Industry on inspected production, make it possible to follow the trend of meat production in interstate and local wholesale plants. The figures are given in Table 15 (p. 168).

The comparison of federal inspection with the wholesale meat production as given in this table shows that the proportion of the wholesale output under local or no inspection rose from 19 per cent in 1909 to 22.9 per cent in 1927; in absolute figures, from 1,969 to 3,344 million pounds. This local wholesale production thus increased

¹ Federally inspected meat yield was estimated prior to 1922, apparently upon the basis of the census of the wholesale slaughtering industry.

² Excluding wholesale establishments with a product exceeding \$5,000 in value. In 1919 there were 21 wholesale establishments with an output of less than \$5,000; in 1921, the number was 47.

about 70 per cent between 1909 and 1927. To it should be added most of the unreported slaughter of the custom or co-operative plants.

TABLE 15.—WHOLESALE MEAT PRODUCTION UNDER FEDERAL AND STATE OR LOCAL INSPECTION, CENSUS YEARS 1909-27*

Calendar year	Volume (million pounds)			Percentage of total	
	Federally inspected ^a (interstate plants)	Not federally inspected (local wholesale)	Total wholesale meat production	Federally inspected	Not federally inspected
1909.....	8,402	1,969	10,371	81.0	19.0
1914.....	8,101	1,998	10,099	80.2	19.8
1919.....	10,577	2,859	13,436	78.7	21.3
1921.....	9,671	2,566	12,237	79.0	21.0
1923.....	11,923	3,718	15,641	76.2	23.8
1925.....	11,179	3,276	14,455	77.3	22.7
1927.....	11,272	3,344	14,616	77.1	22.9

* Data for wholesale meat production compiled from *Census of Manufactures*, and federal inspection from Bureau of Animal Industry, *Meat Production, Consumption, and Foreign Trade in United States, Calendar Years 1900-1927*; other total wholesale output obtained by subtraction.

^a The report of the federal Meat Inspection Service covers "inspected pounds," and therefore contains duplications arising from re-inspection.

The upward trend is particularly evident in hog slaughter. In the proportion of "wholesale" hog slaughter outside of federal inspection there has been a striking increase, as shown below,¹ in million animals:

Hog slaughter	1921	1923	1925	1927
Total	40.73	57.02	48.07	47.5
Federal inspection	38.98	53.33	43.04	43.6
Balance, not federally inspected.	1.75	3.69	5.03	3.9
Percentage not federally inspected	4.3	6.5	10.5	8.2

¹ Computed from data in Table 12, p. 160.

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In 1921, 4.3 per cent of the total wholesale slaughter of hogs was in plants operating under state or city inspection, or under no inspection; in 1925 it was 10.5 per cent, or over 5 million head, and in 1927 apparently receded to 3.9 million. Some changes in the reports (to a fiscal instead of a calendar year) of a number of large interstate plants affect the comparability of the figures for 1927. The percentages are more significant than the absolute numbers, which give a misleading picture because the total number of hogs slaughtered fluctuates greatly from year to year.

For federally inspected meat there are reasonably accurate data from 1907 to 1922, when the meat yield from such accurately reported slaughter was estimated. Thereafter, when supplemental reports were compiled by the Bureau of Agricultural Economics, the data for federal inspections appear to be quite accurate. Upon total meat production, and the production outside of federal inspection, annual estimates are issued by the Bureau of Animal Industry. The summary estimates are reproduced in Table 16 (p. 170). Doubtless these are the best that can be made upon the basis of the fragmentary data that are available. So far as concerns total slaughter and meat production they are scarcely more than informed guesses, because no census has been made of retail slaughter since 1909, no allowance appears to have been made for the custom kill, no data are available for farm slaughter except for 1909 and 1919, and no information is available as to the average meat yield from animals handled by such slaughterers. Even for 1909 and 1919 it was necessary to estimate the meat equivalent of the retail and farm kill, which must differ materially from the known yields in federally inspected plants. In intercensal years prior to 1921 it was also necessary to estimate federally inspected and wholesale yields. In a rough way the official estimates perhaps serve the widespread demand for

statistics upon total slaughter, meat production, and consumption; but they afford quite unreliable bases for determining the proportion or magnitude of the slaughter not subject to federal inspection, or the per capita consumption of different kinds of meat—as officially calculated and widely employed.

TABLE 16.—OFFICIAL ESTIMATES OF PRODUCTION OF BEEF, VEAL, PORK, MUTTON, AND LAMB, 1909-28*

(Dressed weight, million pounds)

Calendar year	Total	Federally inspected	Other
1909.....	14,362	8,402	5,960
1910.....	13,648	7,836	5,812
1911.....	14,454	8,727	5,727
1912.....	13,749	8,349	5,400
1913.....	13,729	8,267	5,462
1914.....	13,299	8,101	5,198
1915.....	13,816	8,849	4,967
1916.....	14,626	9,677	4,949
1917.....	13,932	9,438	4,494
1918.....	16,405	11,319	5,086
1919.....	16,006	10,577	5,429
1920.....	15,511	9,689	5,822
1921.....	15,182	9,671	5,511
1922.....	16,295	10,539	5,756
1923.....	17,912	11,923	5,989
1924.....	17,867	11,837	6,030
1925.....	17,005	11,179	5,826
1926.....	17,245	11,354	5,891
1927.....	16,872	11,272	5,600
1928.....	16,955	11,317	5,638

* Data of Bureau of Animal Industry, *Meat Production, Consumption, and Foreign Trade in United States, Calendar Years 1900-1928*. As explained in the text, the "total" and "other" meat are rough approximations.

According to these estimates (given in Table 16), about 41 per cent of the total meat production was non-federally inspected in 1909, and only about 34 per cent in 1927. Part of it consists of the farm kill, and the balance is the

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kill in all plants—wholesale, retail, and custom—that operate without inspection or under such state or municipal inspection as exists.

Whatever may be the facts with reference to the trend of slaughter outside of federal inspection, this apparent decline from 41 to 34 per cent is merely the result of the statistical methods employed. To illustrate: According to the official estimate presented in Table 16 the non-federally inspected meat production of 1919 was 531 million pounds less than in 1909. Yet according to other official data (see Table 15, p. 168) the local wholesale slaughter rose by 890 million pounds; and the farm slaughter of hogs increased by 1.4 million head, equivalent to an additional 200 million pounds, more or less.¹ The "slack" is taken up in custom and retail slaughter, thus heavily reduced in the process of computation.

CONCLUSIONS

Upon the present magnitude of the largely uninspected retail slaughter, which was so substantial a factor in 1909, upon whether it has grown or fallen off, upon custom slaughter, and upon the farm sales, there are no data. It is a suggestive fact, however, that the only item in the slaughter outside of federal inspection upon which we have accurate data—the local wholesale slaughter—has risen about 70 per cent since 1914, despite its restricted market and the absence of those economies of large-scale production and distribution that presumably characterize the operations of the large interstate packers. Upon the

¹ Data for the other significant item of farm slaughter in 1919 combined cattle, yielding presumably around 500 pounds per head, with calves yielding about 100 pounds. Hence it is not possible to determine the trend here. Although the combined item of 1.9 million head shows a considerable recession from the 2.5 million of 1909 (see Table 12 and its footnote *b*), there may in fact have been an increase in the meat yield. During the war, measures were taken to prevent farmers from slaughtering dairy calves, and it is probable that this influence held over to 1919, a period of high prices.

basis of the 1909 ratio, a minimum of one-third of the domestic commercial supply is produced outside of federal inspection. To this should be added the unreported custom kill, as well as the farm sales. From this it would appear that the meat supply of at least 30 million of the urban population is supplied by small retail slaughterers largely exempt from regulation, and by larger plants operating under a varying measure of state or local inspection. In 1909 these two classes supplied about 60 per cent of the commercial veal and 37 per cent of the commercial beef. In respect to domestic consumption, it should be noted that the large exports are exclusively federally inspected. In other words, the proportion of the urban consumption supplied by local plants is larger than the figures indicate.

It is beyond the purpose of this inquiry to consider whether this indicates a tendency toward decentralization in the slaughtering and meat-packing industry, or to consider the economic and regulatory factors that enter into the situation. The subject deserves separate and detailed study, in which the rôle of the Meat Inspection Act cannot be ignored. It is unfortunate, however, that so little information is available regarding the non-federally inspected production. Even the statistical data, essential to a clear view of this branch of the industry, are meager and of questionable accuracy.

The chief unknown factor, the retail slaughter, apparently represents a volume of meat products that exceeds the entire international trade in beef, or in pork, fluctuations in which are regarded with great concern. A repetition of the census of retail slaughter, made in 1909, and resumption of census reports upon co-operative and custom slaughter, seem to be the first essential to an informed view of the problem. In default of this it would seem that a fair approximation could probably be determined without great difficulty if a special inquiry were

made by the federal Department of Agriculture.¹ The Meat Inspection Service of that department, with a corps of officials in all the large cities, possessing the requisite local information and technical equipment, seems to be the best medium for such an inquiry. While such officials may conceivably be regarded with suspicion by local producers, they doubtless are in position to obtain the co-operation of state and local officials.

It follows from this analysis that there are no trustworthy data, save for the incomplete report in 1909, upon the domestic production and consumption of meats and lard. This is all the more noteworthy in that current estimates exert a substantial influence upon prices. Estimates of the volume of total and "commercial" production, as well as consumption, may vary by hundreds of millions of pounds according to the mode of approximating the ratio of slaughter to livestock population, as well as the three items of retail kill and yield of products therefrom, the farm production of meats and lard, and the proportion of such farm production that goes into commercial channels.

It should in fairness be stated that for the years immediately following 1909 (and in the absence of any better method) the government estimates based on that year were probably reasonably close to the facts. But the war and post-war years witnessed many changes in the animal and meat industries. The fact of these changes is well known; a definite measurement of them, however, has never been made. In any event, estimates based upon conditions nearly two decades ago probably have scant application to the altered conditions of today. Doubtless the estimates which initially seemed fairly adequate were continued to meet a widespread and many-

¹ If the program for a national census of distribution is adopted, retail slaughter might be determined in connection therewith, since meats from such slaughter are sold in meat markets directly to consumers.

sided demand for such information; probably also they have been altered and adjusted upon the basis of the best obtainable data. Yet the data as issued carry no statement concerning the wide margin of error or the basic assumptions that were made, or the essentials of the method used. The excellent form and definiteness of statement give the reports a misleading semblance of accuracy and comprehensiveness. Even changes in the annual per capita consumption of the different classes of meat are calculated. A clearer recognition of their imperfections and the serious need for accurate data upon these important subjects should result in the necessary steps for procuring the requisite supplemental information.

To summarize: The data indicate that there has been an increase in wholesale meat production as an entity, but at the same time the percentage of the total produced in local wholesale plants has increased. On the surface, this would indicate a progressive tendency toward decentralization of wholesale slaughter. It is probable, however, that this is largely a geographic decentralization, for it is a familiar fact that the large meat-packing companies are meeting the situation by erecting or acquiring new plants. Concerning the trend in retail slaughter and in farm and custom kill, we know nothing definite. The broad conclusion of indefiniteness emerging from the above holds for the fats as well as for the meats.

CHAPTER IX

THE RENDERING INDUSTRY

After the foregoing digression into the subject of statistics of slaughter and meat production, we return to our main theme. In this chapter we consider the rendering industry proper, and in the next the municipal reduction industry. Both industries produce inedible fats as their major product.

Rendering, strictly speaking, is done whenever fat is tried out; but in the trade the word "renderer" has come to have a special meaning to designate a person or concern that produces inedible fats from meat wastes and animal by-products. While in this sense rendering is done in the inedible departments of packers, the term "renderer," or rendering establishment, is usually applied to persons or plants engaged in the production of inedible fats from purchased or assembled materials. The slaughterer in the main renders the by-products of his own killing and cutting operations; the renderer salvages purchased and assembled wastes or renders by-products purchased from slaughterers. To the slaughterers the production of inedible fats is a minor incident of their operations; to the renderers it is the main end, and it ordinarily furnishes the product of major value. Rendering represents, therefore, the grease and tallow industry proper. It also produces feed and fertilizer, hides, casings,¹ and other packing-house products.

In the ordinances of many towns and cities rendering

¹ Animal casings (used as containers for sausage and industrial products) are not classed as meat foods under federal meat inspection regulations, and are therefore as a rule not inspected even in the "official" plants.

is defined still more narrowly. A renderer in such ordinances is in effect one who renders dead and fallen animals; and the existence of rendering plants is often prohibited within the city limits on the ground that they create a nuisance. They must be located outside the city boundary, and this requirement has certain important economic effects to be discussed later.

HISTORY AND DEVELOPMENT OF THE INDUSTRY

A distinct salvaging or by-product industry of this kind is more subject to vicissitudes than the usual type of manufacture. Its supply of raw materials has been affected by changes in the organization of the meat-packing industries, in conditions of transportation, and in the geographic distribution and food habits of the population. Its products have been directly affected by contemporary changes in the major industries producing fats and oils, feed, and fertilizer. Apparently the history of the rendering business falls into two fairly distinct periods.

In the first period, the business seems to have been mainly an adjunct or "satellite" of the slaughtering and meat-packing industry.¹ Slaughtering and meat packing

¹The record of this period is briefly traced by Clemen, *By-Products in the Packing Industry*. Prepared with the aid of many well-known packing-house experts, long in the industry, this study of packing-house by-products is an authoritative one. To quote (pp. 2-3): "There grew up around the larger packing plants a number of satellite industries, which bought the unfinished product of the plants. . . . With time, however, the production of these by-products was taken over by the packer himself. . . . The smaller industries dependent upon the packer for raw materials disappeared after they had shown the profitable use of by-products."

Again (pp. 309-10): "Many small renderers utilizing by-products were established around the packing plants. These rendering plants were operated largely by Europeans, who took steer heads, dehorned them, extracted the slugs (insides), prepared the horns for European markets, and converted the leftovers into glue, fertilizer, and other products. They also prepared bones for export markets, and extracted the glue and fats from the trimmings, selling the residue for fertilizer materials. Most of these waste materials, consisting of entrails, livers, hearts, shanks, heads, hoofs, tails, and trimmings of hides and scrapings from the hogs, were at first given away to these rendering plants for the hauling. Later charges were made, and this eventually grew into a by-products business."

were then two distinct and largely dissociated industries, concerned almost solely with the production of meats. In this period of rapid expansion neither had much interest in the elaboration of offals. The concentration of slaughterers in the great packing centers resulted in immense quantities of such waste. Much of it was at first incinerated or buried, or went to the sewers or rivers, presenting a sanitary problem somewhat similar to that now faced by municipalities with respect to the disposition of city garbage (see pp. 219-38). Gradually there developed around these plants a number of by-product enterprises, renderers, glue and fertilizer works, and so forth. These industries, transplanted from Europe, seem to have been pioneered by Europeans. Considerable numbers of such plants are reported in Europe, ranging from plants of substantial size to units operated by small butchers.

The successive integration of slaughtering, meat packing, elaboration of by-products, wholesaling, and transportation, the rise of the "Big Five" (since the Armour-Morris merger, the "Big Four") and their commanding position in the interstate trade—all these constitute a familiar phase of American economic history. Each of these great corporate units represents, of course, the merger or control of many large establishments, strategically located in different sections of the country. It was a logical and apparently necessary step for such large and efficient producers to absorb the by-product industries, in order to reap, among other "internal economies," that of continuity of process. In consequence, many of the small auxiliary industries nearly disappeared. Moreover, through chemical and plant control the great packing units improved the processes of production, increased the number of derived products, and bettered their quality. At the same time new uses and new markets for them were developed.

This transition marked the end of the first period in

the evolution of the rendering business. Of the second or current phase of its history there exists no published record, but the sequence of events seems to be clear. Slaughterhouse offals constitute the most desirable grade of raw material. But the by-product of the large slaughterers was no longer available. Likewise, dead or unfit animals from the public stockyards had come to be processed in plants located at the yards (sometimes a monopoly at the big stockyards) or sent to the inedible departments of the slaughtering plants. With the decline in the number of horses and other livestock within or near the cities, that source of animals has greatly diminished in importance. Against a reduction in the supply of materials from such sources, however, is to be set off a growing recovery of other offals and wastes. Apparently the total amount of recovered waste today greatly exceeds that of the first period.

Mainly, the sources are three. One consists of the physical wastes in the distribution and consumption of meats. The expansion of over 45 million in the total population between 1900 and 1928 has been almost entirely a growth in the urban population, accompanied during the past decade by an absolute decrease in that classed as rural. An incidental result of the striking growth in the number and size of the cities has been the concentration of masses of animal and meat wastes in the urban districts. Urbanization has also been attended by a notable change in the food habits of the population, involving greater waste, and by an increasing patronage of hotels and restaurants. Renderers have found it commercially practicable to collect the trimmings, suet, spoiled and unused meats, bones, and so forth, from meat markets, hotels, restaurants, and similar sources of large accumulation. The average large city contains thousands of such establishments. Better roads and the motor truck have substantially contributed to this de-

velopment. Motor trucks now frequently make "stops" and collections within a radius of thirty miles and more from the large cities. Indifferent success has thus far attended the attempts to reclaim the wastes (garbage) of households, although a number of the larger cities maintain reduction plants for this purpose; of this, more will be said presently. With the exception of such household garbage, however, the salvaging of the waste products of meat distribution and consumption has materially increased. More efficient methods of extraction, and rising prices and growing demand for the derived products, have stimulated the expansion.

Moreover, slaughterhouse offals, the second type of raw material, remain an important source. In fact, collections from many small slaughterers probably exceed, in the aggregate, the supply formerly obtained from the large establishments. The development of dairying and truck farms near the growing cities, the relative increase in the use of fresh meats (as compared with the cured product), and the stated effects of separate federal and local meat inspection, have all tended to expand local slaughter. Local butchers compete with the interstate packers in nearly every city, such local killers ranging in number from one or two in small cities to a cluster of small and fairly large establishments in the larger centers. Such clusters usually develop local auxiliary enterprises producing sausage and various edible specialties, casings, glue, and so forth. All these relatively local industries usually operate outside of federal inspection, and many sell wastes and offals to the renderers.

Finally, with better country roads, a third source, fallen animals, is becoming increasingly important. In the course of time a larger proportion of the millions of farm animals that perish from disease, exposure, and other causes may be salvaged. The average by-product value of a fallen steer, exclusive of the hide, is nearly \$10.

Between the earlier and the present status of the rendering industry there are a number of well-defined differences, in respect to raw materials, geographic distribution of plants, and diversity of products. In the first period the industry, relying chiefly upon offals purchased from the large slaughtering establishments, was largely concentrated in the great packing centers. In the second period, characterized by a larger use of the wastes in consumption and distribution, the plants became widely dispersed. Renderers are now to be found in nearly every city of fair size. Present materials are much more varied, inferior in quality on the average, and must be handled for longer distances. These disadvantages are offset by more efficient extraction and better transportation, and by the larger demand and better prices for the derived products. A greater proportion of the output of the early renderers consisted of products other than tallow, grease, and tankage; that is, of hides, bones, horns, glue, neatsfoot oil, and also edible specialties.

It should not be assumed, however, that the share of the meat packers in the reclamation of animal and meat wastes is limited to the operation of the packing plant proper, chiefly utilizing plant offals. The changes in the organization of the meat-packing plants have exerted a twofold influence upon the business. Some effects of the concentration of the successive stages of manufacture in the same plant or under single management have already been noted. Equally important have been the effects of the absorption of related enterprises. According to the well-known investigation of the Federal Trade Commission, many if not most of the larger rendering establishments were owned by Armour and Company and Swift and Company jointly, separately, or through their employees. The report of the Commission, which dealt with the period 1914-17, contains suggestive data upon some phases of the history and organization of the busi-

ness. It gives separate consideration to "stockyards renderers" (plants located at the public stockyards, exclusively or largely engaged in the processing of dead or condemned animals) and plants doing a general salvaging business.¹

Over 93 million meat animals were handled in 1928 in the public stockyards of 67 markets, of which about 9 received the major portion. Chicago received nearly 16 million head, while the receipts of several markets such as Kansas City and Omaha ranged between 5 and 8 million.² In the loading, unloading, and rail transportation of range and farm stock there is a considerable loss through death and injury. There is a further loss through rejection at the yards on account of disease. If the total of such losses amounts to but $\frac{1}{2}$ of 1 per cent of the receipts, in the larger public yards it would represent a rendering business of substantial proportions. The Commission's report stated that the dead-animal business of the largest public yards (until 1920 likewise controlled by the large packers)³ was a monopoly, owned individually or jointly by the Big Five. Since the issuance of that report other public yards have become more substantial factors. We have, however, no precise information concerning the present nature of the control over these yards or the salvage business connected therewith.⁴ Control over this business would exist as a

¹ *Report of the Federal Trade Commission on the Meat-Packing Industry, Part 3* (June 28, 1919), pp. 157-89.

² *Crops and Markets*, January 1927, IV, 10.

³ The Consent Decree was entered February 17, 1920, against the five largest packers and 80 other corporations, as well as 50 individuals, all of whom were associated with some one of the five defendants named. On March 19, 1928, the United States Supreme Court overruled a motion on behalf of the packers to vacate the decree (see 72 L. ed., p. 350). In a later decision the Court eliminated the California Canneries as intervenors in the case. The Consent Decree, now approaching a final stage of adjudication, enjoins the defendants from holding any interest in any public stockyard, and so forth, and from manufacturing, selling, or buying (with stated exceptions) 114 enumerated food products and 30 other named articles.

⁴ No criticism of the fact of such ownership is here intended. It seems, on its face, a logical extension into a closely related and profitable business.

matter of course in the case of private yards, which have increased in importance.

We reproduce below certain data from the report showing stockyards renderers owned by the three largest packers in 1915 and then enjoying a monopoly of the dead-animal business of the stated yards:¹

Public stockyards	Name of rendering plant	Capital stock
Chicago	Globe Rendering Company	\$2,000,000
Kansas City	Standard Rendering Company	1,000,000
Omaha	Union Rendering and Refining Company	100,000
East St. Louis	East St. Louis Rendering Company	240,000
Sioux City	Iowa Rendering Company	25,000

The capital stock is stated to represent mainly contract rights and good will. It affords, however, some indication of the capitalized worth of the plants. The reported earnings were at a high rate. The data seem to imply a magnitude of operation contrasting sharply with that of the typical rendering plant (see Table 18, p. 193).

Of special interest is the section of the Commission's report which deals with plants that do a general rendering business. Only a modest capital and limited technical equipment are needed for launching an enterprise of this sort. Much depends upon the personality of the operator in his dealings with butchers, retailers, and farmers. A small plant run by an owner-manager with one or two workmen enjoys a number of advantages over a large plant. Yet in the large cities, concerns of substantial proportions usually dominate the field. The report, quoting hearings, correspondence, and court orders, describes the methods which have contributed to the growth of the large concerns and placed them in a controlling position.

¹ *Report of the Federal Trade Commission on the Meat-Packing Industry, Part 3, pp. 61-69.*

Competitors were bought or forced out in various ways, the purchased plants sometimes abandoned, prices of raw materials temporarily raised to a prohibitive level, territory and customers apportioned. In such practices the large packers and a fertilizer company were stated to have taken the lead, though restriction of competition was by no means confined to these interests. It should be added that practices of this kind were formerly not at all uncommon in business in general and are not found to nearly the same extent as before. It may perhaps be assumed, in view of relatively recent restrictive legislation, that the stated conditions no longer exist.

If these facts be correct, they explain some phases of the history of the business. For example, both the number of plants and the total output seem to have expanded notably between 1920 and 1923, although this was a period of falling prices and business depression. The expansion seems to have closely followed the agitation resulting from the investigation of the Federal Trade Commission, the "Consent Decree" of 1920, and the enactment of the Packers and Stockyards Act of 1921. It may be only a coincidence; but the number of plants seems to have increased in several cities where restrictive practices were stated to have been in force. It is difficult to account, however, for the disproportionate number of plants in the different cities, compared with population and meat consumption.

Table 17 (p. 184) shows the number of renderers in each of the principal cities of the United States (arranged in order of population, census of 1920), according to lists of renderers compiled in 1921 and 1927 by *The National Provisioner*. There is evidently no clear tendency for the number of plants to vary with the size of the city, and in general the great packing centers show a relatively small number of plants. The facts suggest the query how prices of raw materials are determined in cities or towns con-

taining only two or three renderers, since the market for offals is essentially a local one.

TABLE 17.—NUMBER OF RENDERING PLANTS IN PRINCIPAL CITIES, 1921 AND 1927*

City	Rendering		City	Rendering	
	1921	1927		1921	1927
New York City and portions of New Jersey—			Baltimore	9	15
New York	5	13	Pittsburgh	4	10
Brooklyn	6	11	Los Angeles	2	3
Trenton, N. J.	2	1	San Francisco	7	6
Secaucus, N. J.	20	12	Buffalo	10	6
Newark, N. J.	9	6	Milwaukee	2	5
Chicago	13	9	Washington	3	2
Philadelphia	16	15	Cincinnati	12	14
Detroit	3	2	New Orleans	1	2
Cleveland	7	12	Minneapolis	8	9
St. Louis	8	5	Seattle	4	4
Boston	7	7	Indianapolis	6	7
			Oakland	2	3
			Kansas City, Mo.	1	1
			Fort Worth.....	..	1

* *National Provisioner Renderer's List* (mimeographed). For the inclusive number of plants, in the environs of the largest cities as well as in the city proper, see Map (pp. 202-3).

The indications are that a substantial proportion of the general rendering business has been and probably still is under the control of a few great concerns, now including four large packers and one chemical company. According to the quoted report, in 1917 about seventeen rendering and collecting companies were parties to an agreement districting the territory in Boston and part of New England. In all New England, Swift and Company controlled a total of nineteen plants, Armour one, and the Agricultural Chemical Company three. In Chicago a number of small plants were stated to be in existence, but the business was largely in the hands of three large com-

panies owned by packers or their employees. In New York City two plants were controlled by Swift and Company, nine by Armour, and two by the Agricultural Chemical Company. The large packers owned one of the three companies in Kansas City, one of the two in Denver, and the plant in Sioux City. The Agricultural Chemical Company was stated to control the situation in Toledo, Buffalo, and Detroit.

In all, about forty plants were stated to be owned by the large packers and about nine by the Agricultural Chemical Company. There is no reason to suppose that such ownership has changed since that date. These forty-nine establishments constitute slightly over 5 per cent of the 913 plants listed by *The National Provisioner* in 1927,¹ but their combined output represents a large share of the total product of the rendering industry. In 1916, of the packer-owned companies, the Consolidated Rendering Company of Boston was stated to have a net worth of over 3½ million dollars; Darling and Company of Chicago, slightly less than 2 million; the Standard of Kansas City about 1 million; while the capital stock of the Globe Rendering Company of Chicago was about 2 million. No data are available upon the value of the output of these companies, but it doubtless greatly exceeds these figures. The commonest size of the independent renderers is one with an output of well below \$100,000 per annum. The four companies listed above are doubtless the largest renderers in the United States, probably in the world. Darling and Company of Chicago was stated to operate more than thirty collecting routes in Chicago and adjacent territory, reaching 139 different communities.

¹ For the year 1921, the *Packers' Encyclopedia* gives the names and addresses of 823; and the revised list of the same source for 1927 includes 913 "live" names. We may infer that the actual number is larger because of the difficulty of compiling a complete list of small establishments of this kind scattered throughout the country.

RAW MATERIALS AND PRODUCTS

Elsewhere (pp. 46-88) we have discussed the sources of raw material, the processes, and the products of the rendering industry. Here only a few words need be added.

Packing-house by-products are an important class of raw material, particularly where the unofficial slaughter is of substantial dimensions. From these by-products a few of the larger operators (where permitted by regulation) also prepare food specialties for a local trade. For example, they contract with slaughterers for heads, feet, pluck (hearts, lungs, trachea), paunch, tails, bladders, blood, and slunks (fetuses); prepare specialties such as brains, tongues, tripe, sweetbreads, and sausage casings; and render surplus and inedible materials.¹

As already mentioned, small slaughterers frequently consign to the renderers certain killing by-products which in modern packing-house practice would go into a variety of food products or to food fats. Some even dispose of all hog fats to renderers, such material yielding a high grade of "white hog grease" instead of lard. In general, nowadays, the slaughterhouse offals available to the renderer yield tallow of the best inedible grade and of relatively high titre. Sometimes the demand for tallow is more active, and a renderer who is able to obtain a large proportion of slaughterhouse offal is able more effectively to dispose of other meat wastes by using the slaughterhouse fats as a stiffening.

Within recent years some change has taken place in the wastes from public eating places available to renderers. Through an increasing use of the "stock boiler," the large hotels and restaurants are saving for food use the better quality of meat trimmings and bones. Not a

¹ Prohibition is stated to have adversely affected the market for such specialties, since much of this product formerly went to the saloon trade. The highway lunch stand has replaced the saloon as purveyor of sausage.

few render part of the by-products for a homemade shortening. In addition, many sell to hog feeders the available swill, or animal and vegetable food waste. This type of disposition seems to be growing. Nevertheless, the rendering industry is apparently getting a larger total of material from public eating places and institutions. Because of differences in restaurant practice, this material is a variable and often a heterogeneous class of waste, some of it quite similar to the household garbage collected by municipal reduction plants. In the large hotels or restaurants the main types of refuse are usually gathered in separate containers. Part of the waste is high in fat content, either because of its character or because oils and fats were employed in cooking or seasoning. Used or spent shortenings consist, of course, almost wholly of fat, and fat is present in varying degrees in unconsumed cooked meat and fowl, in trimmings, in material from the grease traps or interceptors (installed in the kitchen sinks of the large establishments or in connection with dishwashing machines), and in cooked or raw vegetable residue or parings. The tendency of consumers to reduce the intake of fats is reflected in the large amount of fatty residue available in the restaurants, as well as in the trimmings from meat retailers.

Restaurant waste yields a fat of fair quality known as house grease. It is dark or discolored, but low in free fatty-acid content. When the more heterogeneous class of material is rendered, the digester process is almost invariably used, and the tankage is passed through screens and over magnetic separators to remove cutlery, glass, crockery, and the like.¹ However, most of the residual material from house grease is virtually a garbage tankage, and sells at a correspondingly low price as a fertilizer base. Some renderers buy dried stick, blood, hoofs, and

¹ The remaining glass is thoroughly pulverized. It is asserted that thoroughly pulverized glass is not harmful in feeds.

cracklings to bring up the ammonia or protein content. A crude kitchen or household soap is often produced from house grease, mainly for trading back to restaurants.

In many sections the collection of dead or crippled farm animals has materially increased. Better conditions of transportation, ordinances compelling farmers to dispose of such animals by incineration or in other sanitary ways, and sharper competition for raw material have been factors in this development. Likewise, there has been a large increment in the supply of butchers' suet, scrap, and bones. Part of this growing volume of material is a natural consequence of the concentration of population in urban centers; part, also, is the result of the demand for smaller cuts and lean meats, entailing more trimming and waste. Butchers' scrap yields tallow of good quality, and tankage or cracklings of a very high protein content.

These are the main classes of renderers' raw material—slaughterhouse offals, butchers' scrap, hotel or restaurant wastes, and dead animals. As previously indicated, renderers collect almost any kind of animal matter that is locally available in sufficient abundance to pay for the cost of collection.

In localities served by two or more competing renderers there is a notable tendency toward specialization in particular kinds of raw material. One plant will mainly collect restaurant wastes, another butchers' scrap, a third may have the city contract for dead animals, or collect farm stock. Apparently such specialization reflects a *modus vivendi*, often after a period of stiff competition for raw materials. Since volume is essential to profitable operation, and a renderer is substantially limited to local materials, such competition is destructive. Moreover, if competition is not too keen, a good deal of the material may be obtained for the hauling. Under such conditions it is very natural for renderers to reach a working agree-

ment. Whatever be the cause, in areas served by more than one renderer such specialization is quite common. The alternative has been and still is adopted—that of bidding up prices of materials to an unprofitable level and driving out a weaker competitor. After which the survivor remains temporarily in possession of the field.

For most classes of renderers' raw material there is only a narrow market. Butchers' scrap and slaughterhouse offal are the more valuable materials, and in the larger centers are the subject of regular quotations. With this exception, prices vary widely according to the local competitive situation. It should be borne in mind that animal matter putrefies rapidly, and municipal ordinances and state laws usually require that it be disposed of quickly and in a sanitary manner. Consequently the owner would be put to expense for the removal or incineration of such waste if it is not collected by renderers. A large hotel or restaurant usually obtains compensation for meat wastes or refuse; a small establishment may be glad to have it removed without cost, or may even pay a small fee therefor. Municipalities often contract with a renderer for the collection of city animals and pay a substantial sum for this service. The award of such contracts is often attended by a familiar brand of local politics. Renderers, however, frequently pay several dollars a head for dead or crippled farm animals; but they may pay only the cost of the telephone call from the farmer or owner asking for the removal of such stock. It depends largely on the local situation.

As will shortly be seen, however, there are indications that the industry is working to a sounder and more stable basis. The improvement of roads and the motor truck have brought in the competition of renderers within a radius of fifty miles or more, especially of the large city establishments. Against such competition with home industry protection sometimes has been sought and obtained

from the city fathers in the form of local ordinances and taxes of different kinds. Similar wheel or other taxes are occasionally assessed against hog feeders. The industry is clearly passing through a period of transition.

The major products of rendering, as we have seen, are tallow and grease, tankage and cracklings. Renderers usually dispose of their product fats through brokers, on chemical analysis or sample. The residual tankage and cracklings are usually sold to wholesalers and compounders of mixed feed and fertilizers. The production of commercial feed and fertilizer is a large and specialized business, closely regulated by state laws which require registration, certification of chemical composition, proper labeling, and so forth. Moreover, the trade chiefly demands a "complete" or balanced feed and fertilizer, requiring an admixture of other ingredients. The output of the average renderer is too small to warrant the development of distributive machinery to reach farmers and small buyers. However, some large renderers prepare mixed fertilizer and mixed feed.

There are a number of minor products and by-products of rendering. A few of the large plants process fats for stearic acid and red oil, as well as lard oil and grease stearin. A considerable quantity of soap is produced, usually to trade back to hotels or restaurants from which wastes are bought. Large bones are separated and sold to glue and bone processers, and there is a considerable output of hides, casings, bladders, and the like. Presumably, and doubtless usually, only inedible products are sold by renderers, but some produce certain food products. This, however, depends upon local regulations so far as intrastate sales are concerned.¹

¹It is reported from apparently well-informed sources that at least in some sections of the South local renderers collect hog fats and produce and sell lard; and that occasionally a local packer buys waste and trimmings from retail butchers and uses it so far as he can in edible products.

TREND OF PRODUCTION

In the absence of other information, the only method of tracing the development of the rendering business is through the statistics of tallow and grease production. Since these are the main products, they afford a fairly satisfactory index of its growth. As we have already seen in comparing the record of different groups of producers (Table 7, p. 107), in 1914 the renderers' output of tallow and grease (combined) was about 134 million pounds; in 1919 it rose to 188 million; in 1921 to 361 million; and in 1923 to 415 million. During the war period of high prices, therefore, the net increase was only 54 million pounds, while in the subsequent two-year periods there were successive increases of 173 and 54 million. Accordingly, production appears to have been more than trebled between 1914 and 1923. After a recession in 1925, production reached a record figure of over 420 million pounds in 1927, the latest year for which such data are available. The most marked expansion occurred during the years immediately following the World War, a period of deflation and falling or low prices for fats and oils no less than for most other commodities. The decline in 1925 seems to have been in grease, while tallow increased. In that year the hog slaughter was nearly 10 million head below that of 1923.

Unfortunately, the data upon production do not admit of a segregation of the output of renderers from that of municipal reduction plants. Roughly, municipal reduction contributes 10 to 15 per cent of the combined output, and none of this is tallow. Of the United States production of inedible tallow in 1927, renderers produced 234 million pounds, or about 60 per cent; and of the grease production, 187 million or slightly more than half. Viewed from another angle, tallow constituted in that year over 55 per cent of the animal fats produced by the "tallow and

grease industry" (see p. 108). To the renderers, the relative importance of tallow-yielding materials is in fact considerably greater than 55 per cent; for included in their 182 million pounds of grease, produced in 1927, is over 93 million pounds of "garbage and house grease," much of it the output of the municipal reduction plants. If half the garbage and house grease be deducted (pp. 237-38), the proportion of grease in the output of the renderers falls to only 32 per cent. Some allowance, however, should be made for the practice of mixing grease with tallow according to market conditions (see p. 116). Manifestly, however, the predominance of tallow confirms the general opinion that relatively small quantities of hog products go to the renderers; that the chief raw materials are from cattle and sheep, that is, slaughterhouse offals, dead or crippled animals of the stated classes, and trimmings or scrap obtained from the retail distributors of beef, lamb, and mutton.

ORGANIZATION, LABOR, PLANT, AND CAPITAL

The census of manufactures, to which one turns for the statistical outline of the rendering industry, is here of limited service. It gives no data upon the physical volume of production; and only the combined value of total output is stated prior to 1925, so that even the relative value of the various products cannot be determined. Moreover, it classifies under the "tallow and grease industry" only those plants of which the products of chief value are tallow and grease. If other products, such as fertilizer, feed, or edible products, are of larger value, the plant is allocated to other industries. Since in the rendering industry fertilizer, feed, bones, and so forth, constitute a considerable proportion of the value of the total output, changes in their relative value may result in frequent shifts in classification even though there be no change in the character of the operations of the plants

shifted. The report for 1921 does in fact state that the data for different years are not comparable because of such shifts. Finally, the census does not include plants with outputs valued at less than \$5,000 per annum. For these and other reasons the number of plants included in the classification "tallow and grease industry" is only a fraction of the number classed by the trade as renderers. The census data do, however, cover a sufficient number of plants to give a fairly satisfactory indication of their average size, output, and labor outlay, and the distribution of the various items of gross income.

TABLE 18.—DEVELOPMENT OF ESTABLISHMENTS REPORTING TALLOW AND GREASES AS THE PRODUCTS OF CHIEF VALUE, CENSUS YEARS 1909-27*

Year	Number of			Costs and values (thousand dollars)			
	Plants reporting	Wage earners		Wages paid	Materials, fuel, and power	Value of product	Value added by manufacture
		Total	Per plant				
1909.....	358	4,357	12.3	2,629	15,543	23,419	7,876
1914.....	369	5,106	13.8	3,512	17,061	24,901	7,840
1919.....	482	6,647	13.8	7,954	47,766	67,265	19,509
1921.....	265	4,428	16.7	5,429	17,787	27,206	9,419
1923.....	254	5,248	20.7	7,004	31,275	48,634	17,359
1925.....	263	5,308	20.2	7,508	33,713	51,442	17,729
1927.....	247	5,062	20.5	7,403	33,272	56,280	18,008
Year	Averages per wage earner (dollars)			Averages per plant (thousand dollars)			
	Wages paid	Value of product	Value added by manufacture	Wages paid	Materials, fuel, and power	Value of product	Value added by manufacture
1909.....	600	538	1,808	7.4	44.0	66.3	22.3
1914.....	690	498	1,535	9.5	46.2	67.5	21.2
1919.....	1,200	1,012	2,935	16.5	99.1	139.6	40.5
1921.....	1,280	614	2,127	20.5	67.1	102.7	35.5
1923.....	1,330	927	3,308	27.6	123.1	191.5	68.3
1925.....	1,420	970	3,343	28.5	128.2	195.6	67.4
1927.....	1,465	1,114	3,564	30.0	154.9	227.8	72.9

* Data from *Biennial Census of Manufactures, 1921*, p. 894; *1925*, p. 852; and *1927*, preliminary report.

Between 1914 and 1927, according to the census (Table 18), the average number of wage earners per plant rose from fourteen to about twenty men; the annual wages per man, from \$690 to \$1,465; the annual wage-roll per plant, from \$9,500 to \$30,000; the value of products per plant from \$67,500 to \$227,800. In 1927 the total value of products was \$56,279,958, of which tallow and grease made up \$30,095,271, or 53 per cent, and "other products" (fertilizer, "poultry feed,"¹ tankage, hides, bones, and the like) \$26,184,657, or 47 per cent, compared with 40 per cent in 1925. Apparently "other products" are tending to bulk larger in the business than animal fat. No doubt this is in considerable part a result of the growth of dry rendering, which has increased the yield and value of cracklings (not separately reported). The improving market for hides and other by-products has been a contributing factor. Materials, supplies, and containers constituted 64.3 per cent of the value of total product in 1927, purchased fuel and power was less than 3.8 per cent, and wages only 13.1 per cent.

The rendering process is a machine process, requiring the services of a moderately skilled mechanic. The bulk of the labor charge is for unskilled labor employed in the collection of animal and meat wastes. In 1925 the total number of wage earners was 5,303, an average of about twenty men per establishment (263 plants reporting). Of this number, twenty-seven plants employed a total of 2,595, or about half. If these exceptionally large plants be excluded, the average number of wage earners for the remaining 236 plants is slightly over eleven. As noted below, a large number of very small plants are not taken into account in obtaining this average.

Evidently, notwithstanding the large aggregate value of the products of this industry, its component units are

¹ Probably cracklings.

unusually small and with limited capital.¹ The commonest plant is in fact considerably smaller than is indicated by these data. In the first place, account should be taken of the omission of all plants with an output of less than \$5,000. The number of such units is indicated by the statement that in 1921 the census received (but did not tabulate) reports from 125 of such plants, nearly half as many plants as were actually tabulated. Secondly, a large portion of the reported output was produced by a few large subsidiaries of certain meat-packing and fertilizer companies, such subsidiaries being usually located in the great urban centers. In 1925 (the latest year for which this information is available) nine plants reported an individual output of a million dollars or over, totaling 18.8 million, and an additional eighteen reported a product of between \$500,000 and 1 million, or 11.5 million dollars for the group. Accordingly, twenty-seven of the 263 reporting plants produced about 60 per cent of the total, and the average output of the remaining 236 renderers falls to about \$90,000 instead of \$195,600, without taking into account the number of small plants omitted in the census.

Small as the most common type of plant appears to be, the figures clearly show a marked trend toward a larger scale of production and a larger utilization of capital, especially when allowance is made for changes in the level of prices. They confirm the view, current in the trade, that the drift is toward a more specialized plant and better technology. The very material increase in average number of wage earners per plant, from 12.3 in

¹ The trade directory cited above lists over 900 renderers. Upon this basis, the number of plants in this obscure business exceeds that reported by most of the manufacturing industries covered by the census. Of American industry, the common notion is one of stupendous value of total product. This is true of about two-score manufacturing industries; but approximately one-half report a total output smaller than that of the rendering plants—i.e., about 50 million dollars; a larger proportion employs 20 wage earners or fewer per plant and an output per plant of \$100,000 or less.

1909 to 20.5 in 1927, is especially significant in this connection, for it does not depend upon changes in costs or in the level of prices. Wages per worker have more than doubled; hours of labor have doubtless been reduced. Yet the ratio of labor expenditure to total value of product has actually declined slightly. It is especially noteworthy that per wage earner the average value of product and the "value added by manufacture" have more than doubled since 1914.

High rates of insurance and the high fire risk from fat-soaked timbers, and rapid deterioration due to the acidity of the materials handled and consequent rapid corrosion of equipment, are forcing the replacement of barn-like structures or warehouses by concrete buildings. The relatively new process of dry rendering is also reported to be effecting notable changes in plants. Replacements and new installations are usually dry-rendering units. In some well-informed quarters the recent growth of the industry is supposed to be the result of this development. In some of the older establishments its adoption has been slow because it entails the abandonment of a fairly expensive plant.

The development of modern equipment and more efficient or speedy methods of handling are not only bettering quality and increasing the yield, but they are also making it possible to operate with a minimum of objectionable odors, and largely to do away with the pollution of streams. Affording an economical method of disposing of meat wastes, fallen animals, and so forth, the rendering plant has been regarded nevertheless as somewhat objectionable, and tolerated only because it seemed necessary. It has been limited by various forms of public regulation, located far from the residential districts, and in some cities permitted to operate only at night. The new equipment entails a considerable capital outlay, and its adoption may be slow. Nevertheless, it seems likely to effect

ultimately a material change, both in the character of the industry and in the public attitude toward it.

RESULTS OF A SPECIAL CENSUS OF THE INDUSTRY

For the year 1925 the federal Bureau of the Census added an important supplement to the usual data of the biennial census with respect to the rendering industry—the “tallow and grease industry” proper. A special questionnaire was sent to the 263 reporting plants; and the returns received from 157 are summarized in Table 19 (p. 198). Of necessity, such a supplemental questionnaire was limited in scope and simple in form. The results, however, may fairly be taken as a cross-section of the industry.

Of the 157 reporting establishments eight were garbage reduction plants (presumably making only grease and garbage tankage or fertilizer), and one was primarily a “presser” or processor of fats for lard oil, and the like; the rest were renderers. Their aggregate product was valued at nearly 30 million dollars, or about 60 per cent of the total for the entire rendering industry as covered by the census in the same year. Their production of tallow and grease was 221 million pounds, also about 60 per cent of the total. Their average output of all products is valued at \$189,000, and their production of tallow averaged 1.4 million pounds per plant. The product appears to be more diversified than that of the usual plant, since seven processed grease for lard oil, five produced tallow oil, and the value of “other products” is large.

The combined production of tankage, feeds, and fertilizer is shown to be about twice that of tallow and grease. In other words, the material treated yielded 1.9 pounds of by-product tankage for every pound of inedible fat.¹ It seems reasonable to assume that some such ratio

¹ It may be that purchased compounds for mixed feeds and fertilizer are included in these items. A producer of cracklings, however, is very likely to report his product as “animal feed” or “poultry feed” and one of garbage tankage as “fertilizer.”

TABLE 19.—PRODUCTS OF 157 RENDERING AND REDUCTION PLANTS, 1925*

Products	Number of establishments reporting	Quantity (pounds)	Value (dollars)
Grand total.....	157	.....	29,697,959
<i>Inedible primary fats and greases, total</i>	156	221,446,259	19,748,874
Tallow.....	118	165,749,682	15,447,282
Grease, total.....	86	54,605,627	4,188,448
Garbage.....	16	21,294,817	1,388,562
House.....	30	20,092,567	1,765,554
Hog.....	10	1,775,862	115,441
Other.....	48	11,442,381	918,891
Neatsfoot oil.....	8	308,855	42,769
Horse oil.....	7	782,095	70,375
<i>Secondary or derived animal oils</i>			
Tallow oil.....	5	1,776,384	149,616
Lard oil.....	7	3,680,186	385,764
<i>Other products</i>			
Feeds and fertilizers, total..	116	422,111,325	5,822,687
Tankage.....	91	184,401,855	1,826,192
Fertilizer.....	25	153,692,222	1,790,823
Animal feed.....	32	81,610,346	2,161,365
Cracklings.....	5	2,406,902	44,307
Glue.....	8	12,361,421	886,453
Hides.....	61	.....	1,544,517
Other.....	55	.....	1,160,048

* Based on mimeographed report of the U.S. Bureau of the Census, *Inedible Fats and Greases Industry, 1925*, from special census taken in that year. The original report has here been rearranged, totals computed, and several minor alterations made upon the basis of correspondence with the Census Bureau.

obtains in the industry at large. Upon this basis the production of tankage and cracklings by all renderers and reduction works can be estimated at 356,000 short tons, and by slaughterers and meat packers (excluding the by-product from edible fats), 327,000, or a total of 683,000 short tons. The actual yield is probably higher. Of the

156 rendering and reduction plants, ninety-one reported tankage, five cracklings, thirty-two animal feed, and twenty-five fertilizer. Some plants reported under more than one of these classifications. The net number reporting tankage, feed, and so forth, was 111, leaving 46 plants with no apparent yield of this joint product. It is probable that meat meal, bone meal, and so forth, may have been erroneously included with "other products."

Most of the grease, as was to be expected, is reported under house and garbage grease. It is noteworthy, however, that while only 8 of the reporters were garbage reduction plants, 16 in all reported garbage grease. Evidently a number of renderers collect and process garbage of different kinds, perhaps under contract with the cities. Only 7 of the 148 renderers reported horse oil, to a total of 782,095 pounds.

In quantity and value the output of tallow is about three times that of grease. It will be noted that 118 plants reported an output of tallow, and the net number reporting grease was only 86. Evidently a considerable number of plants produce tallow but no grease. The diversity of operation is indicated by the fact that 60 plants reported "other products"—bones, casings, bladders, and perhaps food preparations of different kinds; 61 plants, or about 40 per cent of the total, reported an output of hides, and 8 made glue.

The regular biennial census of manufacturers gives some data upon the volume of the renderers' output for the year 1927, for the first time. It embraces only 247 plants (doubtless the large establishments, contributing the great bulk of the total product), and reports only three items, the rest being classed in "miscellaneous products," which constitute nearly 40 per cent of the value of output. The data follow on page 200.¹

¹ Data from preliminary typed report, kindly furnished by the Bureau of the Census.

	Quantity	Value
Grease, including soap stock (<i>lbs.</i>) . . .	104,370,865	\$ 6,892,862
Tallow (<i>lbs.</i>)	295,563,328	23,202,409
Tankage (<i>tons</i>)	152,847	4,782,722
Miscellaneous products*		21,401,965

* Evidently includes cracklings with other products such as glue, hides, and the like, as well as a good deal of tankage in the form of mixed feeds and fertilizers.

PRESENT GEOGRAPHIC DISTRIBUTION OF RENDERERS

The rendering industry shows a peculiar geographic distribution. On the "dot" map (pp. 202-3) we have located the 913 establishments in the inclusive list for 1927 of *The National Provisioner*. A cluster of plants will be observed in or near each of the large northern and Pacific Coast cities, such as Boston, New York, Philadelphia, Baltimore, Chicago, and San Francisco.¹ Over 85 per cent of the plants are dispersed in the northern tier of ten states from Iowa eastward. This is of course the most densely populated and industrialized region of the country; it contains also the great bulk of the slaughtering and meat-packing industry. As shown by Table 20, the largest number of slaughtering plants is found not in the great meat-packing centers, but in such states as Pennsylvania (152), Ohio (120), New York (117), and California (94). Illinois follows with 81 and Indiana with 58.

A noteworthy feature is the density of rendering plants in several northern states. Here the business seems to be carried on in every city or town of fair size. Taking the northern tier of states, westward, Massachusetts contains 51 rendering and reduction plants, New York 79, New Jersey 35, Pennsylvania 98, and Ohio 81. Indiana, second in number of plants, contains 111, and Illinois 61. The largest number, 123, appears in Iowa. In the thickly set-

¹ In the case of the large cities the dots only approximately indicate location of plants, because of the number of dots to be placed in a small area near New York, Chicago, and so forth.

THE RENDERING INDUSTRY

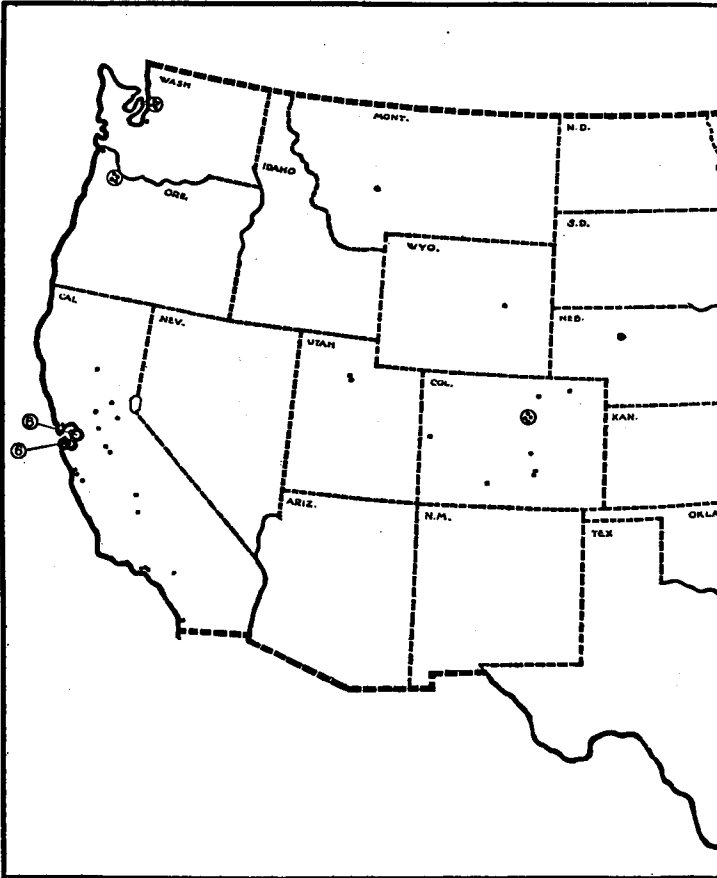
TABLE 20.—GEOGRAPHICAL DISTRIBUTION, 1927, OF (A) 1,249 WHOLESALE SLAUGHTERING AND MEAT-PACKING PLANTS, AND (B) 913 RENDERING PLANTS, BY STATES AND GROUPS OF STATES*

Region or state	A	B	Region or state	A	B
North Atlantic	367	313	Delaware	9	6
East North Central	323	294	Maryland	40	21
West North Central	128	172	District of Columbia	8	2
South Atlantic	116	45	Virginia	26	4
East South Central	45	16	West Virginia	9	1
West South Central	42	16	North Carolina	7	0
Mountain	81	15	South Carolina	4	1
Pacific	147	42	Georgia	8	3
Maine	11	7	Florida	5	7
New Hampshire	2	9	Kentucky	21	9
Vermont	0	2	Tennessee	13	2
Massachusetts	40	51	Alabama	8	5
Rhode Island	6	6	Mississippi	3	0
Connecticut	4	26	Louisiana	9	4
New York	117	79	Texas	24	6
New Jersey	35	35	Arkansas	2	5
Pennsylvania	152	98	Oklahoma	7	1
Ohio	120	81	Montana	17	1
Indiana	58	111	Idaho	14	0
Illinois	81	61	Wyoming	4	1
Michigan	45	19	Colorado	25	11
Wisconsin	19	22	New Mexico	1	0
Minnesota	12	21	Arizona	8	0
Iowa	21	123	Utah	9	2
Missouri	45	9	Nevada	3	0
North Dakota	2	0	Washington	36	5
South Dakota	5	7	Oregon	17	5
Nebraska	14	7	California	94	32
Kansas	29	5			

* Data for slaughtering and meat-packing plants from *Biennial Census of Manufactures, 1927* (preliminary); for rendering plants, from a list compiled by *The National Provisioner*, October 1927.

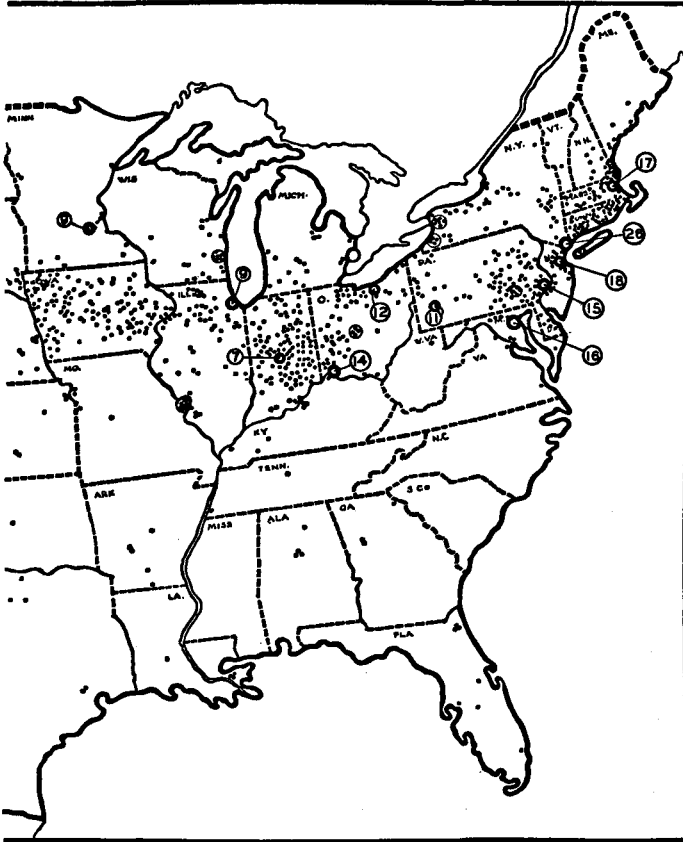
tled New England states, or in New Jersey, Ohio, and Indiana, the density may doubtless be accounted for by the importance of dairying, the amount of local slaughter,

DISTRIBUTION OF RENDERING ESTABLISHMENTS



* See Table 20, p. 201. Establishments are located by "dots." A circle marks at a particular city, the number of plants in the city or circle being

IN THE UNITED STATES, OCTOBER 1927*



indicates the concentration of a considerable number of rendering establishments indicated in the margin or elsewhere.

and the magnitude of meat consumption. But in Iowa it would seem that renderers are located in nearly every city, as well as in villages and in the countryside.

The number of plants in Iowa is surprising in view of the fact that it is an agricultural state, relatively sparsely populated, with few large cities and meat packing well concentrated. We find upon investigation that the history of this development dates back to the war period. Iowa produces more livestock than does any other state in the Union. Even the normal losses from disease and other causes are large in the aggregate. Carcasses of dead animals represent a substantial potential yield of fat, fertilizer, and feed, and markets for fertilizer and feed products are close at hand. Moreover, such carcasses are also a source of contagion, and the laws of the state require speedy disposal by incineration or otherwise. Losses from hog cholera during the war were heavy, and a law was enacted allowing the operation of rendering plants for the conservation of fats, for which there was a large demand.¹ Subsequently such plants were required to operate under license and regulation. In 1927, 125 such plants were licensed.² It is unlikely that an equal density of plants will develop in other great livestock-producing states. In the nature of the business, it would seem that wider and more constant sources of material are necessary to profitable operation. According to trade advices, considerable numbers of such plants in Iowa, as well as in

¹ The war called "for an enormous amount of nitroglycerine, one of the component parts of which is glycerine, obtained as a by-product in the manufacture of soap from certain fats and oils . . . 10 tons of fat are required to yield 1 ton of glycerine." H. S. Bailey and B. E. Reuter, "The Production and Conservation of Fats and Oils in the United States," U.S. Dept. of Agriculture, *Bulletin 769*, February 1919, p. 1.

² It seems also that the development was accelerated by one or more manufacturers or sellers of rendering machinery, who interested local capital and sold and installed equipment. Apparently some of these plants have been idle for much of the time, and some, after changes in price and other conditions, were never operated.

Indiana, operate only part of the time, during periods when farm losses are heavy.

A striking feature of this distribution is the virtual absence of rendering plants in a large part of the South and in the Great Plains area. In fourteen southern and western states the total number of such plants is only nine. Texas, with several cities of substantial size, contains six; Tennessee two; South Carolina one; and none is reported in either North Carolina or Mississippi. New Orleans contains two plants, compared with eight or more in northern cities of equal size.¹ The entire South contains only about as many renderers as Ohio.

The probable future course of events is apparent when account is taken of the industrialization and urban development of the South and West; of the ultimate growth in local slaughter and livestock population of the South; also the growth of dairy farms, usually marketing calves locally. All these influences suggest that it is only a question of time until numbers of such plants will spring up in these areas, although such a development may be slow.²

SOME ECONOMIC CHARACTERISTICS OF THE INDUSTRY

In view of the familiar fact that the forces of modern industry work against the existence of small units, it may be worth while to inquire into the reasons for the persistence of the rendering business in its present form and distribution. Indeed, in many respects it is strikingly different from characteristic American enterprises, and a large proportion of the plants appear to be operated and managed by persons of recent European origin.

Although the derived products enter into a world-wide

¹ By correspondence with informed local officials we have confirmed some of the data with respect to scarcity of plants in the South.

² It is noteworthy that in the tick-infested areas the animals must now be slaughtered locally, shipment beyond the state borders being forbidden.

trade, factories must be located within easy hauling distance of their raw material. It should be collected and rendered quickly, since it putrefies rapidly, with consequent reduction in quality and yield of the derived tallow and grease, and tends to become a nuisance. It is obviously impracticable to transport the raw material by common carrier. Thus the rendering business is essentially a highly localized one, arising either from a local concentration of non-federally inspected and small slaughterers, or from a large urban population with its accessory hotels, restaurants, meat markets, domesticated animals, and local dairy farms. Plants center in the segregated "butcher towns" of the metropolitan districts, or on the fringes of small cities.

Limitations upon the volume of raw material accessible to a plant, together with its lack of homogeneity, not only restrict the size of plant, but also inhibit the introduction of the most effective technique. Equipment and methods of production are relatively simple; and the industry has been slow in adopting the changes effected in other branches of the oils and fats industry. Yet the business appears to be shifting to a larger and more specialized type of production. The products of the large renderers are becoming nearly as varied and specialized as those obtained from offals in the large slaughtering and meat-packing establishments. Although both large and small plants exist side by side, the business of the great cities is increasingly dominated by the bigger units. The small plants, although numerous in the aggregate, appear mainly in the smaller communities. The motor truck and better roads are changing the situation. The large and efficient producers are gathering materials from an ever widening territory, encroaching upon the business of small local units. Competition for raw material raises prices, reduces volume below the cost of economical operation, and narrows the margin of profit. Conditions

such as these are forcing out the smaller and less efficient plants. "Chains"—plants in different sections under a single ownership or control—are increasing in number. Where some sort of agreement is not reached, the competitive situation often becomes bitter. If the large plant can force out smaller competitors it remains in control of the field and can obtain the various types of refuse or waste upon virtually its own terms.

An unusual feature of the business is its comparative stability. It suffers little from hazards of a type common to industry in general. Raw materials, the chief item of cost, are contracted for upon the basis of product prices or are obtained for the hauling. Fixed charges, except for deterioration and insurance, are relatively low, and the rapid turnover largely eliminates inventory losses. For tallow and grease there is an active domestic and foreign market; the residual tankage and cracklings enjoy a ready market for use in feeds and fertilizers. A similar stability obtains with respect to volume of operation, for materials are either the result of food consumption, which in the local aggregate does not vary greatly, or of the operations of small slaughterers whose output is relatively more constant than that of the large interstate establishments.

Rendering as a business of reclaiming animal wastes is distinct and largely dissociated from the meat-packing industry, except in the case of some of the largest plants. In the meat-packing industry the yield of inedible fat is correlated with livestock slaughter and the production of meat, whether for domestic trade or for export. In the rendering plants it is only indirectly so correlated, being more closely related to the domestic consumption of meats.

The query naturally follows: Why have not the large interstate packers engaged more extensively in this allied business? It has already been noted that a number of the

more important rendering concerns are or were owned by the great packers (see pp. 180-85). But the great majority of such plants are independently owned and operated. Supplying meat markets and grocery stores with a wide range of products and carrying such distributors on credit, the meat packers are obviously in a better position to obtain shop fats and meat wastes. Their operations have extended into many more or less directly related branches, soap, vegetable oils, leather, butter, oleomargarine, poultry, eggs. Tallow, fertilizer, feed, and the like are packing-house products of considerable importance. Moreover, it is precisely for the derivation of many products from such offals as are processed by the renderer that the meat-packing establishments are noted. No comparably effective use is made by the tallow and grease industry. One would naturally expect the great packers to concentrate upon the control of rendering. If large numbers of independent plants nevertheless exist, the answer is apparently to be sought in the limitations upon the size of the plant and the relatively modest turnover, involving the management of numbers of small units; in the fact that it is a type of business well adapted to the owner-manager system; and chiefly, perhaps, in the various local and other restrictions upon the entry of outside offals into the premises of the packing plant.

CHAPTER X

MUNICIPAL REDUCTION

THE PROBLEM OF MUNICIPAL WASTES

Municipal reduction is the recovery of grease and tankage from kitchen waste or garbage,¹ in plants owned and operated by the city, or in subsidized private plants under long-term contracts with the city. Its characteristics and problems can be more clearly understood after a brief discussion of municipal wastes in general.

The rapid growth of American cities has given urgency to the problem of disposing of the increasing volume of municipal wastes of many kinds. This involves considerations of public health and convenience, as well as difficult economic and technical problems. The main classes of refuse must, as a rule, be differently handled; and the methods vary greatly from city to city, in part because local conditions present different opportunities of solution. Frequent revision of existing systems of disposal is forced by the development of cities and suburbs, objections to the pollution of streams, and the obsolescence of existing facilities. Although progress has been made in recent years, methods of handling city refuse are still in an early stage of development. It is properly a problem of sanitary engineering; but the ultimate decision as to method or methods rests with laymen or local politicians.

Of the main classes of refuse, one or all may be gathered and carted by the municipality or by private scavengers, usually under contract. Of the various methods of disposal, likewise, one or more may be operated by the

¹ In addition to city garbage, reduction plants may dispose of dead animals.

municipality or by private contractors, under some form of subsidy. The technical and economic problems are difficult enough; but these are complicated by local politics, particularly in respect to the award of contracts for collection and cartage, and the erection of either or both incinerators and reduction works. The merits of different systems advanced by competing manufacturers; the question whether carting and the operation of such systems shall be conducted by the municipality or by contractors, and what the terms of such contracts shall be—all these are matters of more or less perennial dispute. It is not often that the different methods are co-ordinated into a reasoned general plan, and in consequence there is duplication of functions which lessens efficiency and adds to cost. In many respects the situation is chaotic; and local "exposures" of scandals relating thereto are not infrequent.¹ In a great city the necessary capital investment in plant, trucks, and other equipment usually runs well over a million dollars; and current operating costs are heavy. For all these reasons, matters relating to the disposal of municipal wastes seem to be rather constantly before most cities.

The term "municipal waste" is applied to a varied class of city wastes, distinct from the type generally called sewage. One of the more important and troublesome classes of such refuse is garbage, the term applied to animal and vegetable waste from kitchens of households, restaurants, hotels, and institutions of various kinds. Other important classes are street refuse—snow, leaves, waste building materials—dead animals, and trade, house, and market rubbish such as ashes, paper, rags, and the like. These are the usual classifications. Garbage consists primarily of organic matter, of animal and vegetable

¹ The statement is frequently made that if one can find who really controls garbage disposal contracts, one is quite likely to learn who is the real political boss.

origin. Other refuse contains inorganic matter such as cans, metals, and so forth, as well as organic material in the form of leather, paper, rags, and wood. Cities frequently limit themselves to the collection of household and street refuse, and contract with renderers for the collection of dead animals. Apartment houses, hotels, restaurants, factories, and stores are often required to make their own arrangements for the handling of refuse. On the surface, such a procedure appears to limit the expenditure of the municipality. In reality, as will shortly be seen, it materially increases the total cost to the community, owing to the duplication of functions and lessening of efficiency.

The volume of municipal refuse is large, and costs of collection and disposal are high. The volume and constituent materials vary greatly in different cities, according to the proportion and kinds of manufacture, the extent and prosperity of residential districts, the amount and character of fuel consumed, and other factors. In a study of conditions in Rochester, New York, it was found that in 1917 each person was responsible, on the average, for over 1,700 pounds of ashes, rubbish, and garbage, or about two cubic yards per capita. In Springfield and Cambridge, Massachusetts, the per capita collection of ashes, rubbish, paper, and garbage was reported in 1925 to be 1,805 and 1,967 pounds, respectively, exclusive of other large quantities of municipal wastes of various kinds requiring disposal, such as those arising from the cleaning of streets, dead animals, and other waste animal matter, earth from excavations, and other wastes from construction.¹ No account, likewise, appears to have been taken of the materials gathered by renderers and hog feeders. From these

¹ "Report of the Department of Public Health upon the Matter of the Disposal of Garbage, Waste, and Other Refuse throughout the Commonwealth," Commonwealth of Massachusetts, *House Document 337*, December 15, 1925, pp. 4-9.

and other data it would appear that in the average large city a figure for wastes of this kind of a ton per person would not be far from the truth.

In costs of collection and disposal there is a wide range. On costs of collection and cartage a few fragmentary data are available. The data quoted below do not include heavy costs of incineration, reduction, and so forth. Nor are the figures for collection and cartage inclusive, because such figures embrace the direct or immediate charges paid by the city. To the figures should be added the payment for the disposal of dead animals, and the expenses incurred by stores, factories, hotels, restaurants, and apartment houses, in cities where these are required to make their own arrangements for the handling of refuse.

In the Rochester study the cost of collection for the year 1927 was found to be \$1.43 per capita. For an average household of four persons this would be about \$5.72 per annum. The Municipal Index for 1926 gives costs of collecting garbage in a number of the large cities. In Chicago, Detroit, St. Louis, Cleveland, Philadelphia, and Los Angeles such collection costs ranged from \$4.35 to \$5.00 per ton; in Pittsburgh it was \$7.03; in Washington \$3.70, and in Dayton only \$2.21 per ton.¹ Some cities defray this expense directly through the general tax rate; others make a special assessment for collection; and in some, designated or other scavengers deal directly with householders and business houses. The rate for stores and factories is higher than that for households. Rates and methods of assessment vary greatly in different communities.

There are several different methods of disposal, many cities utilizing several of them. One of the commonest and most satisfactory is incineration, which reduces the

¹ *Municipal Digest*, 1926, published by *American City Magazine*, New York.

bulk of the waste by about 60 per cent or more, but still leaves the question of disposal of the residue. Others are dumping in oceans, bays, or rivers, dumping on land, or burying in sanitary fills.¹ For garbage, two other methods are in use, hog feeding and municipal reduction. There are objections to each of these methods.² It is obvious, however, that city refuse contains a great deal of recoverable products—fats, fertilizer, feed, material for rubber goods, paper (tar, roofing, wrapper, and writing), metal products, and the like, and that ashes and similar refuse may be used in filling in low-lying land. Incineration sacrifices the recoverable value, but is often least costly under present conditions.

One of the factors contributing to the high cost of collection is the necessity of locating incinerators and reduction works at considerable distances from the centers of population with correspondingly increased costs of cartage. This necessity arises out of the objectionable odors from such plants, which make them more or less of a nuisance. There is also a considerable quantity of foul drainage and wash water, which may become objectionable unless properly cared for. In a modern incinerator or reduction plant, odors and other objectionable features are largely eliminated. Nevertheless, such plants adversely affect property values in the neighborhood, and the vigorous opposition to them, including legal injunctions against their operation, is a factor that has to be considered. In the case of dumping in streams, dumping on land, or burying, it is likewise necessary to haul the material a

¹ "Sanitary fill" is the term given to filling properly drained ground with thin layers of garbage covered by deeper layers of earth. In other cases the garbage is deposited in shallow trenches in well-drained soil, where it is covered with a layer of earth, ashes, or other material. Where the ground is porous the garbage disappears sufficiently so that the land may be used again within a year. Commonwealth of Massachusetts, *House Document 337*, pp. 4-9.

² R. Hering and S. A. Greeley, *Collection and Disposal of Municipal Refuse* (New York, 1921), chapters vii, viii, x, xi; C. H. Hyde, *California State Board of Health Special Bulletin 40*, 1921.

considerable distance; furthermore, the development of suburbs and extension of cities frequently render such methods impracticable.

DUPLICATION IN SERVICES AND UNNECESSARY COSTS

In few cities is there to be found a co-ordinated plan for the collection and disposal of refuse. The problem is attacked piecemeal, and costs are unnecessarily enhanced by the duplication in services.

It is not unusual, as already remarked, for a city to charge itself with the collection of street and household refuse—a household being defined, for example, as a residence containing not more than four families—and to require that apartment houses and business institutions arrange for the disposal of wastes arising on the premises. Proximately, this seems to reduce the expenditures of the city; actually, it materially increases the burden upon the community, in several ways. There is the obvious duplication in cartage, since the municipal trucks and wagons cover part of the territory of the private scavengers. Total costs of disposal are also materially enhanced. A modern incinerator of sufficient capacity to treat the combustible refuse of a large city entails a capital expenditure of as much as a million dollars; and the initial cost of an adequate reduction plant for the treatment of garbage runs up to half a million dollars, more or less. Many cities operate both. Overhead costs are also heavy. Such plants are or can be operated in shifts, on a 24-hour day, the cost per ton being materially reduced by running at capacity. It is obvious that when the municipality and private enterprise dispose of wastes independently the total cost is higher than it should be under a single management. There is a further duplication in cost of dumping grounds or fills.¹

¹ Swamps, bay shores, and lake shores have been and may be reclaimed or improved for parks and for business and industrial purposes by using such

In this way the city charges itself with the costliest type of collection, leaving the rest to private enterprise. The cost of collecting refuse from a single large source is manifestly much less than that of collecting an equal amount from a large number of households. It is important to the economical operation of a reduction plant that it should obtain the kitchen or table refuse of apartment houses, institutions, hotels, and so forth. Private scavengers may not deliver wastes to the municipal plant; and because of dissatisfaction with existing conditions apartment houses and other large sources of accumulation are increasingly installing incinerators. It is the usual practice, likewise, for cities—even those which maintain reduction plants—to contract with renderers for the disposal of dead animals. A substantial annual fee is paid by the city for this service. Yet renderers usually pay for larger animals collected from other sources and go fairly long distances into the country for such materials. Moreover, the city already possesses requisite trucks for hauling, and the reduction plant, where one is maintained, should be able to process dead animals. Such material would, in fact, materially improve the quality of its product, especially of the tankage, the low quality of which is one of the main problems of reduction. If the existing facilities are not adequate, it would be a simple matter to add a dry-cooker or digester. Indeed, the annual fee paid by some municipalities for the collection and disposal of dead animals would be nearly sufficient to cover the initial capital expenditure.

Again, incinerators and reduction works are occasionally operated as competitive rather than as complementary services. One great city, for example, collects only street and household refuse. It has erected at great ex-

land as fill for refuse of certain kinds. Inorganic material such as ashes, crockery, and similar rubbish is suitable for filling in low-lying lands. Abandoned brickyards and quarries are also used.

pense both a reduction and incinerating plant, and owns or leases dumping grounds and fills. Factories, stores, apartment houses, hotels, and restaurants are required to make their own arrangements, with scavengers or others, for handling waste materials. Now the city itself operates the reduction plant, while the incinerator is operated by private enterprise, at a stipulated rate per ton, the city hauling the refuse to and from the incinerator. Being paid at a given rate per ton, it is but natural for the incinerator to process garbage as well where such refuse is available. Thereby the volume of material available to the reduction plant has been materially reduced, its cost per ton greatly increased, and its showing made to compare very unfavorably with that of the incinerator. This doubtless will provide arguments for the abandonment of the reduction plant and the installation of another incinerator, presumably of the same make.

In sum, the handling of the varied classes of refuse is one of the more costly and troublesome of the functions of a municipality. The prospect of a substantial advance in the handling of this problem, either in the technological or economic aspects, does not appear to be bright. The character of municipal business of this sort is not one to warrant research and expenditures by manufacturers of the requisite equipment. Each city works out some solution, usually by some sort of compromise between contesting interests. One thing appears clear. Although municipal operation is commonly inefficient, uneconomical, or both, the collection and disposal of refuse must be regarded as a municipal responsibility. For best results, a single board or official, presumably the city engineer, should be charged with the entire task of collecting and disposing of all of the varied types of city refuse. This does not necessarily exclude the services of renderers and hog feeders, who collect the most profitable types of waste. In any event, it seems to be well established that

a city legally may, if it so desires, exercise exclusive jurisdiction over the various types of city refuse. Occasionally cities do in fact restrict hog feeders and renderers.

So much of the general background seems necessary to an understanding of the status of municipal reduction. We turn now to a consideration of the problems and conditions of the recovery of grease and tannage from city garbage.

GARBAGE

Garbage includes all kinds of kitchen or table waste of food products. Such material has been the subject of more discussion than any other class of city refuse, and its treatment has been more varied. Its volume is large. The contained meat and animal wastes in particular decompose rapidly, soon becoming foul in warm weather; hence garbage requires frequent collection and quick disposal, else it soon becomes a serious nuisance. The simpler forms of disposal, such as burying or dumping, cannot as a rule be applied to this class of refuse. Moreover, it contains recoverable plant and animal food and more or less grease, the efficient recovery of which offers an opportunity for reducing costs of disposal.

The volume and composition of garbage reflects current food consumption and related practices. It therefore varies in different cities, in different sections of a city, and with the season and state of business. It is reported to be "richest," to have a higher proportion of meat wastes, in periods of prosperity and full employment. In most cities the volume is smallest during the winter, but it then contains a greater proportion of solid animal wastes, which yield a larger volume and better quality of grease. The amount of garbage rises during the summer, but it is then composed more largely of vegetable matter of low grease

content, is more difficult to handle, and demands more frequent collection.¹

The United States Food Administration estimated the average annual "production" of garbage at 200 pounds per capita.² Since this estimate was made in 1918, during the period of war conservation of foods, it may be too low for ordinary years. The weighted average collection reported for 37 Massachusetts communities, exclusive of Boston, was 190 pounds per capita in 1924, with a range of from 78 to 337 pounds per capita; but these reports did not include all of the garbage collected in these communities, some of it being collected by rendering and fertilizer plants and others, and a large part of it being collected with ashes and refuse.³ In Bridgeport, Connecticut, and Rochester, New York, it was 200 to 204 pounds.⁴ In the District of Columbia it is about 269 pounds per capita, but this figure is reported to be unusually high, and the true average is lower because Washington's relatively large floating population is not included in this computation. We conclude that the representative figure is evidently well over 250 pounds per capita because the data for these cities usually represent city collections and do not include the large amounts collected by hog feeders, rendering plants, and a proportion that is mixed with other classes of waste. Nevertheless, it will be observed

¹ Raymond Pearl, in *The Nation's Food*, 1920, pp. 246-48, makes an estimate of the "edible waste in garbage: That is to say, the uneaten portion of the prepared food which is edible and might be consumed, but is not for reasons of taste, overestimation of ingestive capacity, etc." Of the fat left in the United States (after exports) at least 25 per cent is lost through wastage. "The figure seems large, but it probably underestimates rather than overestimates the fact. Of the carbohydrates, probably there is 20 per cent of edible wastage." Of the protein in human foods, at least 5 per cent is wasted.

² U.S. Food Administration, *Garbage Utilization* (February 1918), p. 4.

³ Commonwealth of Massachusetts, *House Document 337*, p. 7.

⁴ J. V. Lewis, "Cobwell System of Garbage Reduction, and Some Phases of Its Operation at Rochester, N.Y.," *Proceedings of American Society of Civil Engineers*, October 1926, p. 1675.

from Table 21 (p. 237) that the volume of garbage *processed* in most of the reduction plants ranges from 200 to 328 pounds per capita.

CHARACTERISTICS OF MUNICIPAL REDUCTION

Municipal reduction of garbage arose as a branch of sanitary engineering, rather than as an industry. It appears to have been pioneered in Europe, but the method has gained wider acceptance and been more rapidly developed in the United States, perhaps because of the larger proportion of food wastes in American cities. Dumping, and the use of sanitary fills, are both becoming increasingly impracticable or objectionable for this type of refuse. Excepting hog feeding, shortly to be discussed, the only other method is that of incineration. Improvements in the construction of incinerators have largely eliminated former objections to this form of disposal. Nevertheless it is a costly method; and it destroys materials which may substantially reduce the cost of handling such refuse if such materials can be economically recovered. Owing to its grease and protein content, garbage has a higher recoverable value than any other important class of city refuse.

Like hog feeding, therefore, reduction is a mode of disposing of an important part of the city wastes which holds forth the promise of substantial credits against costs of collection and disposal. So far, its primary purpose has been not to earn profits, but to afford a solution of the perplexing problem of disposing of one of the largest and most troublesome kinds of refuse. With the present methods it is not economical in cities of less than 100,000 inhabitants. The financial results vary according to efficiency of plant and management, and according to treatment of costs of collection, cartage, and certain items of overhead. Most of these are charges which would continue to be incurred were reduction abandoned. If the

proceeds cover costs of operation, good; if not, the plant must nevertheless continue to function unless some less costly method of garbage disposal can be devised, and the taxpayer foots the bill. From this point of view the true cost of reduction is obtained by subtracting normal costs of collection, as well as the cost of disposal by the least expensive of the other methods available. It is noteworthy, however, that several of the most modern plants are reporting a net operating profit.

It follows that municipal reduction is distinctly different from the grease and tallow business proper. It is in much less degree influenced by considerations of costs and profits; it utilizes relatively large masses of inferior and difficult material of low fat content; and it necessitates an extensive, costly, and rapidly depreciating plant, the efficient operation of which requires a considerable measure of technical skill.

Where reduction plants are operated, it is necessary by ordinance to enforce the separation of garbage from rubbish (including street and trade refuse),¹ for only animal and incidental refuse can be handled by reduction. Even so, the separated garbage is a nondescript material, high in moisture content (about 70 to 75 per cent on the average). By present methods of reduction it yields only about 2½ to 3 per cent of an inferior grease, which is purchased chiefly by makers of candles, stearic acid, and soap. "Garbage grease" is a mixture of animal (including fish) and vegetable oils, of a greenish black color in the tanks. It often has a characteristic odor of coffee. This grease is pumped into tank cars for shipment. It must be handled rather expeditiously because of a tendency to harden and sour. Yields vary with the changing constituents of garbage and the methods of extraction. A ton of "green" or raw garbage will yield on the average

¹ Rubbish, where it is sorted, also yields considerable material of value: paper, bags, rags, glass, metal scrap, and the like.

about 50 pounds of grease. Its usual price range is from four to six cents a pound.

The recoverable tankage, after drying, grinding, and removing foreign materials, is on the average about 250 pounds per ton.¹ During the summer, when the proportion of vegetable matter is high, the yield per ton may be considerably larger, although its protein content is less. The reported "production" (see p. 237) is usually only about half the possible yield, even with present methods of reduction, because tankage is made only when there is a market for it. A good deal of the unmarketable product is used as fuel, dumped, or incinerated. The percentage of moisture in dry tankage is about 10 per cent; a larger proportion causes the product to spoil rapidly, losing ammonia in the process. Dry tankage contains about 15 per cent of protein, 3 per cent B.P.L. (bone phosphate of lime), as much as 2½ per cent of unrecovered fat, and much humus-forming material. A pound of dry extracted garbage contains about 3,000 B.T.U. (British Thermal Units).

This garbage tankage is ordinarily used as a base or filler for fertilizers. It sells for \$3 to \$5 per ton, compared with about \$50 per ton for renderers' tankage and cracklings of around 50 per cent protein. Because of the low yield of grease and the relatively high proportion of tankage, it is probable that the future of municipal reduction will depend largely upon an improvement in the quality of the latter. If a substantial part of this residual matter can be made into a feeding tankage its price will be increased at least fivefold, and the gross returns from reduction materially enhanced. Results already achieved

¹ The U.S. Food Administration in co-operation with the Office of Fertilizer Control of the U.S. Department of Agriculture made a very complete survey in 1917-18 covering all the reduction plants, municipal or otherwise. For these abnormal years the recovery per ton of garbage was 262 pounds of tankage in 1917 and 286 pounds in 1918. E. A. Goldenweiser, *A Survey of the Fertilizer Industry* (U.S. Dept. of Agriculture Bulletin 798), October 1919, p. 10.

in one city (Indianapolis), and other experiments conducted by private interests indicate that substantial improvement in the quality of this product is likely to be effected in the near future. Should this eventuate, municipal reduction will be placed upon an incontestable basis as a means of disposing of city garbage. The potential yield of fat, feed, and fertilizer from this source is very large.

PROCESSES

The methods of reduction vary considerably from city to city. Many of the plants are old; replacements and repairs have been frequent; and engineers and mechanics employed within the plant have in time virtually rebuilt the system initially installed, making many alterations suggested by their experience. A large number if not most of the improvements in the methods of reduction have been developed by such employees and by consulting engineers. Equipment manufacturing concerns have not been particularly active in developing machinery for reducing garbage. The business is of an uncertain character, and the conditions attending the procurement of city contracts tend to discourage large expenditures for experiment or research.

There are two principal methods of fat extraction. One is the digester system, and the other that of solvent extraction.¹ In most plants the two appear to be combined. Both systems include a somewhat similar and extensive plant for crushing, drying and redrying, milling, screening, and other methods of removing foreign material.

¹These systems are sometimes classed as four groups: (1) cooking—cooking first by steam and then pressing and percolating; (2) drying—first drying and then percolating; (3) the Cobwell group—material treated in “reducers,” involving the application of solvents, heating, dewatering, and drying; and (4) the Morrison group—cooking and pressing the material in a steam-jacketed digester.

The digester method is similar in principle to that used by renderers and meat packers, already described. There are numerous variations, necessitated by the volume of garbage, its high moisture content, and the presence of foreign materials. In brief, the green garbage is cooked in steam-rendering tanks, of which there are several in each plant. As a rule, only one batch can be handled each twenty-four hours in one of these tanks. The cooked garbage and a large proportion of the tank-water are allowed to separate, greases and tankwaters decanted, and the grease removed. In one system the tankage is dried, foreign materials removed by means of screens and magnetic separators, the residual mass further degreased by solvent extraction, and the tankage finally redried. In the straight digester system the tankage is dried, sometimes being first run through a hydraulic press to facilitate drying, and foreign material removed. Tankwaters are either dried down to a "stick" or run into the sewer.

Of the solvent method, the system employed by the large plant at Chicago is doubtless representative. This plant is one of the largest in the country. The iron boxes in which garbage is collected are hoisted by a crane and emptied into a huge pit; the material is then carried by mechanical conveyors to crushers, thence to large cylindrical primary driers, and again to secondary driers, reducing the moisture content to about 10 per cent. The dried mass is then run into large tanks or "percolators," naphtha pumped in, and the grease solvent run by gravity into evaporators. Here the gasoline and water are evaporated, the grease pumped into settling tanks, and finally into large storage tanks. In this process, steam is applied to the naphtha and water in the evaporator, the resultant vapors passed through pipes to condensers, the liquids passed through separators, and the gasoline run back to underground storage for subsequent use.

After the grease solvent has been drained from the percolator, part of the naphtha is pumped out of the remaining mass, and steam introduced to recover the balance. The degreased mass, now with a moisture content of about 25 per cent owing to the application of steam, is passed through rotary screens to mill driers, and the moisture again reduced to 10 per cent. It is finally milled, again screened, metals removed with magnetic separators, and sold as fertilizer tannage. The material which does not pass through the screens is considered as rubbish and is shipped to the quarries at McCook, Illinois. Vapors from the garbage in the drying processes are drawn into a "scrubber building," where all odors, gases, and dust are washed before passing into the atmosphere.

This Chicago plant is now valued at two million dollars, and it is reported that nearly a million dollars were spent for major improvements and rehabilitation since the city purchased the plant in 1914. Normally the plant treats over 100,000 tons of garbage, producing about 6 million pounds of grease. The production of fertilizer is only about 5,000 tons, because such fertilizer is made only when there is a market for it. The plant has a capacity of 125,000 tons of garbage per annum, based upon a 16-hour day.

The improvements recently developed at the Indianapolis plant merit particular notice, because these foreshadow developments that may profoundly affect the status of municipal reduction. It is reported that costs have been reduced, and yields of product increased in volume and improved in quality. This is notably true of tannage, of which a feeding grade is produced.

First of all, a surprisingly simple and yet important improvement has been made in the method of collection. Garbage is dumped from the household container upon a trailer equipped with a simple dewatering device—a perforated plate over the entire bottom, and a receiving com-

partment below. As these horse-drawn trailers are moved the water drains into the compartment and is emptied at convenient sewer manholes. It is asserted that the elimination of water increases loads, reduces odor and other nuisances, improves quality of the product, and also, perhaps, reduces costs of drying. These trailers are collected by trucks on a regular route and conveyed to a receiving station. There the garbage is emptied, further drained by a similar floor dewatering device, and carried by mechanical conveyors to steam-jacketed digesters, equipped with mechanical agitators. The plant is equipped with forty-two of such rendering tanks. Live steam is turned into the jackets at a pressure of eighty to ninety pounds for about two and one-half hours; the grease-bearing liquid is decanted through screens and baffle boxes to a sump, settled for twenty-four hours, and the grease then skimmed. The residual mass in the digester is pressed with steam, and a vacuum of twenty-six inches produced by jet condensers. After four hours of steam drying with agitation, moisture is reduced to about 7 per cent, and the dry garbage (containing feed in a comparatively fine, dry condition as well as unbroken rubbish) is passed by mechanical conveyors to screens with a $\frac{1}{4}$ -inch mesh. The coarse particles go to percolators, are there degreased with naphtha, and passed to the fertilizer storage. The fine material is carried by screw conveyors, the rubbish, glass, and metals removed by means of screens, magnetic pulleys, and brushes. The foreign material so removed goes to the degreasing percolators, and finally to fertilizer storage. The fine material is a feed, with a glass content of 0.06 per cent, compared with a permissible maximum of $\frac{1}{10}$ of 1 per cent in most of the state regulations relating to stock feeds. From 5.43 tons of green garbage the yield of crude tankage is one ton, of which 52 per cent is feeding tankage, 34 per cent fine rubbish, and 14 per cent coarse rubbish. "Tankage for fertilizer

filler is worth about \$5.50 per ton, while tankage for stock feed is worth \$30 per ton as a minimum.¹ The coarse material conveyed to the percolators at different stages of the process is degreased, and the residual matter milled, screened, and sold as fertilizer.

Several of the distinctive features of this system are the dewatering device, the utilization of the same tank for cooking and drying operations, and the several processes leading to the separation of finely divided stock feed. It is reported that the dewatering device alone substantially reduced the costs of operation by the earlier method. In 1926, by the methods above summarized, the Indianapolis plant showed a net operating profit of \$29,000 on 32,000 tons of green garbage. This is exclusive of interest and depreciation, which are never included in the cost data for city plants. The plant was constructed for somewhat less than the \$460,000 raised for the purpose by a bond issue. It is reported, also, that after grease is skimmed from the tankwater, the remaining liquid contains all the water-soluble materials in the tankage, including sugars, starches, salt, and so forth. Experimental work is being conducted with the view of recovering the materials so lost in the tankwater. It is asserted that even a city of 4,000 inhabitants will soon find it practicable to adopt municipal reduction.

SOME ECONOMIC PROBLEMS OF REDUCTION

Since the product of chief value in a reduction plant has been grease, the net operating profit or loss depends in large measure not merely upon the expenses of treatment, but also upon the yields and the price of grease. The content of fats varies with the proportion of animal wastes contained in garbage, for animal wastes are richer

¹ From *Industrial and Engineering Chemistry*, May 1927, XIX, 608-13. The description above summarizes some of the essential features of the quoted report.

in grease than vegetable refuse; and it varies, also, with the food habits of the different city populations and with the season. But there is another and perhaps even more important factor that affects the quality and quantity of grease and tankage as well as the costs of collection and processing. It is the extent to which local renderers, hog feeders, and scavengers take animal waste that would otherwise go to the reduction plants.¹ To an increasing extent renderers now contract with hotels, restaurants, and retailers of meat for their relatively large accumulations of animal matter. The larger accumulations of swill, also, are commonly collected by hog feeders. Consequently the municipal reduction works chiefly utilize the garbage collected from innumerable households. Manifestly, it costs much more to collect from many households an amount equal to that from a single hotel or restaurant. Moreover, the former material is distinctly inferior and much more costly to process. It combines both vegetable and animal waste, whereas in the large accumulations animal waste is usually segregated.

Partly because of such conditions, and also because of the low price of the kind of tankage now produced, considerable difference of opinion appears to exist concerning the economic feasibility of this method of disposing of household wastes; that is, with the processes now generally in use. Manufacturers of reduction equipment state that the high cost of materials and labor, the low prices of product, and the absorption by renderers of the more profitable sources of grease, have all combined to render this method unprofitable. There are other causes for the unfavorable showing made by some plants. Among these are technical deficiencies in management and plant. Inefficiency of management is attributed to politics. Deficiencies in plant are due in many cases to the fact that

¹ In several cities operating reduction plants, the collection of garbage by hog feeders is prohibited; e.g., in Pittsburgh and Cincinnati.

the plants are very old. A municipal plant, whether operated by the municipality itself or by a private concern under contract, is not likely to be kept up to date. It is a general trait of government to fight shy of making capital expenditures. Governments are always more prone to patch up an obsolescent plant than to junk it and replace it with new and efficient equipment, even though material savings might result. This is especially true for the general run of reduction plants which create more or less of a nuisance. With the rapid growth of many American cities, a plant originally built well out in the country often finds itself surrounded by a suburb much sooner than was anticipated. Property owners then naturally press for its removal. City authorities, not knowing how long the pressure can be resisted, hesitate to recommend a capital investment for modernization.

It is often asserted, to be sure, that with modern equipment it is possible to make a plant quite unobjectionable. On this point, however, disinterested authorities differ. One sanitary engineer of note put the case thus: In theory it should be possible to build a reduction plant that would be unobjectionable; in practice no one has ever done so. The art has not yet advanced to that point; it is not yet possible to build a fool-proof plant. One may be built that operates satisfactorily most of the time; but now and then something goes wrong.

Nevertheless, several municipalities have achieved a considerable measure of success even with the present methods of reduction. One of the most successful considers reduction the logical method, both from an economic and sanitary viewpoint. The construction of the plant, it reports, offers many problems peculiar to a project of this kind. The best of materials must be used; the plant should be designed and constructed by one of the few concerns who have specialized in this field, and through years of experience are familiar with the nature

and requirements of the project. It usually proves costly to entertain ideas of engineers inexperienced in such work or to attempt radical economies in the initial capital expenditures. "Properly constructed, maintained in a satisfactory state of efficiency, and operated accordingly, more satisfactory results could not be wished for."¹ Considering the characteristics of municipal operation of public or quasi-public utilities, the comment above may give the key to the causes of failure and success in municipal reduction. Of course, if the technique of the process is materially improved (as is claimed for the Indianapolis process) reduction will be definitely established in the large urban centers, and may even become feasible in small cities.

COSTS AND RETURNS

That, under such conditions, wide differences in yields of product and financial results should be obtained, is to be expected. We have supplemented published data with material gathered by correspondence, with a view to obtaining recent information regarding the experience of different cities. The results obtained by the cities cited below afford something more than a cross-section of the principal types of operation, since there are now not more than a score of such plants. About seven cities collect and deliver garbage to a private contractor, pay him a substantial subsidy, and allow him in addition the returns from grease and fertilizer. A number of municipally operated plants report a large net operating cost, i.e., net operating loss. A few cities operate municipal plants that show an operating profit, though such profits are not usually calculated as a private business would do. In connection with the costs and returns here cited, it should be borne in mind that the operating cost of an incinerator is close

¹ Correspondence.

to \$3 per ton. In neither incineration nor reduction are interest and depreciation included. Current repairs to plant, however, appear to be included in costs.

The city of Boston has a ten-year contract with a reduction company using a digester process. This plant has been in operation fifteen years. The city pays the reduction company \$345,000 yearly. On the 55,000 tons annually processed, this is \$6.25 per ton of green garbage. In 1926 the company produced about 3,300,000 pounds of grease and 3,850 tons of tankage, with a combined value of \$110,000 (at 3 cents per pound for grease and \$3 per ton for tankage).

Baltimore has a ten-year contract with a reduction company operating since 1921. The city has its own vehicles for the collection of garbage, which is carted to the water front, placed upon municipally owned scows, and carried down the bay sixteen miles from the corporate limits of Baltimore. Each scow carries 200 to 250 tons of garbage; the towage is \$22.50 per scow to the plant, and a similar charge is paid for returning the empty scows to the loading platform. Under the contract, the city also pays the reduction company \$2.70 per ton of garbage.

Other cities which have entered into similar long-term contracts with private interests for the reduction of city garbage are Pittsburgh, Cincinnati, Detroit, Syracuse, and Lorain, Ohio. These contracts are either upon a tonnage basis, or at a flat total payment. Cincinnati, for example, pays \$202,500 annually. Pittsburgh's contract with two reduction plants calls for the payment of \$6.70 per ton for collection and disposal, the total disbursement in 1928 being \$722,306.

So far as we can ascertain, only these seven cities contract with private enterprise for municipal reduction. The remaining eleven plants are operated by the municipalities. In comparing the operating costs of the latter with the contractual payments, it should be borne in mind

that cities do not include interest on investment or depreciation. However, the municipal reports appear to include heavy charges for repairs and new equipment, and depreciation may be virtually offset by these continuous repairs. The interest charge, per ton of garbage, appears to be well below \$1.00. On the whole, however, the net costs of municipal operation are materially less than the subsidies paid to private contractors. The two extremes of municipal operation appear in Indianapolis and Chicago.

The reduction plant of the District of Columbia, originally run by private capital under contract, is now being operated by the District. In the five years 1922-26 it annually averaged 3,468,000 pounds of grease from 73,278 tons of garbage at a cost of \$176,413 and a product value of \$208,766. In addition, the press cake (tankage) is used in the boilers, "saving one-third the price of coal that would otherwise be used." It makes no attempt to prepare fertilizer tankage, because its price (\$5.00 to \$6.00) would not warrant the necessary expense for coal, labor, maintenance of a "dry house," and upkeep of drying, milling, and screening machinery.

Bridgeport, Connecticut, like Washington, owns its own plant, purchased from private contractors in 1920 and since operated by the city. The plant, renovated in 1926, contains twelve 7' x 14' vertical digesters, three horizontal hydraulic grease extraction presses, percolators, dryers, and so forth. The city has been quite successful with this municipal project. The results for 1925 follow:

Quantity of garbage treated	15,120 tons	
Operating cost	\$84,153.94	
Revenues:		
Grease, 894,304 pounds.....	\$68,493.34	
Tankage, 948 tons.....	4,963.47	
Other	12,642.61	86,099.42
Operating profit		\$1,945.48

The experience of Michigan City, Indiana (1920 population, 144,000), is representative of results in a small city. An official stated in reply to our inquiry, in 1927: "Under present prices of grease and tankage the plant can only be operated at a loss. We have not been operating the plant for about twelve months due to this fact. Previous to that time there was a slight profit, but very little. I would not recommend that a city of our size make an investment in a reduction plant, as they cannot be operated economically."

Technical journals indicate that at least two other cities possessing relatively modern equipment have been covering their operating cost. The garbage reduction plant of Columbus, Ohio, handled 30,000 tons in 1926 with a gross operating profit of 44.1 cents per ton. The yield of grease per ton was 47.66 pounds and of tankage, 156.66 pounds.¹

Although Indianapolis suffered abnormal operating conditions in 1927, owing chiefly to a strike, it appears to have been notably successful with the improved methods in its new plant. During the period from June 1 to November 15, 1927, it handled 18,356 tons of green garbage, obtaining 894,170 pounds of grease, 1,061 tons of feed, and 761 tons of fertilizer. The city made a profit of \$1.93 per ton. Under normal operating conditions it would have netted \$2.06. Its cost per ton was \$2.10 and value of product was \$4.03.²

In Chicago the cost of reduction, per ton of green garbage treated, ranged between \$3.07 and \$3.39 during 1924-26. In 1926-27, owing to a number of unfavorable conditions, costs rose to about \$5.50 per ton. These are the net costs after deducting values of grease and tankage from operating expense. In Reading, Pennsylvania, the

¹ *Chemical Abstracts*, February 20, 1928, XXII, 656, quoting *Public Works*, LVIII, 330-31 (1927).

² *Industrial and Engineering Chemistry*, May 1927, XIX, 608-13.

net cost per ton, similarly computed, was \$1.60 in 1927, and in Schenectady, \$3.50, and in Rochester, in 1925, \$1.55. In Philadelphia the net cost (or loss) per ton was only 28½ cents in 1927, and a profit was reported for the first six months of 1928.

In sum, of the eleven municipally operated plants, four (Indianapolis, Washington, Columbus, and Philadelphia) report an operating profit or substantially covered operating costs; two (Rochester and Reading) report a net loss or cost well below the probable cost of incineration; and in Chicago and Schenectady the cost of reduction exceeded the probable cost of incineration. For the remaining three municipal plants no data are available.

TREND OF REDUCTION, TOTAL PRODUCT, AND MATERIALS

The foregoing illustrations serve to indicate something of the range of conditions with respect to the recovery of kitchen waste or garbage. Many plants originally operated by private capital, under contract with the municipalities, have since been discontinued or taken over by the city. A relatively large number of plants were constructed during the World War, especially 1915-17, under the stimuli of high prices and acute shortage of fats and fertilizer, and an effective campaign for the reduction of wastes. Systems were installed in many cities manifestly too small to support such plants under normal conditions. The post-war deflation, fires, unsatisfactory plants or management, and improvement in incinerators—such causes as these subsequently resulted in the discontinuance of reduction in many cities. The present status and current trends are not easy to appraise.

In 1917 reduction seems to have been more commonly in use in larger cities, for in that year reduction plants in twenty-nine cities produced about 72 million pounds of grease and about 150,000 tons of fertilizer tankage. The total value of the material recovered was over 11

million dollars.¹ It was reported that at different times about forty-five plants were installed, but that many were not operating. Of sixty-six cities estimated by the census as having a population of over 100,000 in 1916, twenty-five were burning or dumping their garbage and twenty were feeding their garbage to hogs. Of 544 cities having between 10,000 and 100,000 population, 200 reported their garbage likewise being fed.²

Since that time the number of reduction plants has become less. The Municipal Index for 1926 lists thirty-four cities with reduction plants; but this list is evidently inaccurate. It includes fourteen cities of from 5,000 to 60,000 population in which the existence or operation of reduction plants seems improbable.³ According to information procured by correspondence, only the eighteen cities enumerated in Table 21 (p. 237) maintain such plants.⁴ In sixty-two cities of 100,000 population and over, no reduction works are operated; among such cities are New York, Los Angeles, St. Louis, New Orleans, San Francisco, Oakland, Denver, Minneapolis and St. Paul, Kansas City, Omaha, Toledo, Galveston, and Albany. No plants of this kind are in operation west of Chicago, or in the South.

¹ U.S. Food Administration, *op. cit.* These figures, collected and compiled under the stress of war conditions, should apparently be regarded as being merely suggestive. In another publication dealing with the fats and oils situation (*U.S. Dept. of Agriculture Bulletin 769*) the production of garbage grease in 1917 was originally stated to be 56.2 million pounds. We have, therefore, three sets of figures for 1917, from 56.2 to 72 million pounds.

² Of 602 cities reporting, 102 (including 19 with a population of over 100,000) were destroying their garbage by burning in some form of incinerator.

³ An inquiry addressed to several of these small cities showed that these had never operated such plants. Apparently the term "reduction" is confused with incineration.

⁴ Chicago is about to abandon reduction and turn to incineration. It has already installed one large incinerator. The plant at Lorain is in receivership and will probably be abandoned. It was erected by private enterprise, with the expectation of obtaining contracts with surrounding municipalities. These plans were not realized. Lorain itself is too small to support such a plant.

Through the courtesy of city officials and plant managers we are enabled to present the following summary of the present status of municipal reduction. Our information concerning products relates to 16 of the 18 cities which utilize this method of disposal, such data not being available for Baltimore and Cincinnati.

It will be observed from Table 21 that in 1928¹ the reduction plants of the 18 cities treated slightly more than a million tons of green garbage. In the 16 cities for which such information could be obtained, the yield of grease was 44.6 million pounds and of tankage 86,830 tons. Applying average yields to the material treated in the Baltimore and Cincinnati plants, the total output of all the American reduction plants is about 50 million pounds of grease and about 110,000 tons of tankage. The population of the 16 cities was officially estimated to be about 11.1 millions, and of the 18 about 12.5 millions.²

The figure for "green garbage" represents, as stated, the amount processed in the reduction plants. It does not represent the volume of garbage "produced," because additional amounts go to feeders and renderers. Nor does it represent total city collections, because a good deal is incinerated, dumped, and mixed with other classes of refuse.³ Such variations in the practice of different cities

¹ Of the reporting cities, two gave data for 1927 and one for 1925. Under normal conditions the variations in volume from year to year are not large; with substantial accuracy the data may be said to cover the year 1928. Volume of Chicago reduction is known to have contracted sharply in 1928, but this would not materially affect the totals.

² *Statistical Abstract of the United States, 1928, p. 43.*

³ For example, Philadelphia reports that 39 per cent of the garbage is treated at the reduction plant, 11 per cent goes to the municipal incinerator, and 50 per cent is taken to farms beyond the city limits. The city wagons also haul garbage to transfer stations, where it is transferred to privately owned trucks and taken to stock farms beyond the city limits. Apparently these data refer only to municipal collections, for it is added that hog feeders are licensed by the Philadelphia Bureau of Street Cleaning to contract with hotels, etc., and to collect from private residences. Apparently an increasing proportion of the city garbage goes to such sources, for the amount treated by the reduction plant dropped from 76,168 tons in 1927 to 71,632 tons in 1928.

are reflected in wide differences in the amount of garbage treated, per capita. For the 16 cities the average was about 157 pounds per capita; but in Philadelphia the average was only about 70 pounds, in Chicago, 67 pounds, and in Boston, 139 pounds; whereas in Cleveland, Detroit, and Washington the corresponding amount of green garbage treated in the city reduction plants was 222, 261, and 269 pounds per capita, respectively. In Pittsburgh and Cincinnati, where hog feeders are not permitted to operate, the average is 329 and 310 pounds, respectively.

The yield of grease per ton of raw material likewise varies greatly. The average for the 16 cities is 51 pounds per ton, or about 2½ per cent. Upon the basis of the reported total yields and volume of material treated, Cleveland, Pittsburgh, and Washington show a grease extraction of 40, 41, and 43 pounds per ton, respectively; while the corresponding figure for Philadelphia, Chicago, and Boston is 52, 55, and 60 pounds per ton. These variations reflect differences in the quality of the raw material treated as well as differences in operating efficiency.

For the 16 cities the average yield of tankage per ton of green garbage was slightly less than 10 per cent, or about 197 pounds. As stated before, the actual production of tankage is often below the potential yield because this by-product is processed only when there is a demand for it; that is, when prices warrant the cost of drying, separation of foreign materials, etc. It will be noted that no tankage was produced in the city of Washington, and in Chicago the yield of tankage was below that of grease, while in a number of cities the yield is rather large. In Cleveland it is 12.5 per cent, or about 250 pounds per ton.

The largest municipal reduction works, it will be noted, are those of Detroit, Cleveland, Chicago, and Pittsburgh. The volume of material treated in these four cities approximates that in the remaining sixteen, combined. Yet from the cost data already cited, as well as from the data

TABLE 21.—MUNICIPAL REDUCTION PLANTS: VOLUME OF RAW MATERIAL AND PRODUCTS*

City	Year	Green garbage (tons)	Grease produced (thousand pounds)	Tankage produced ^d (tons)	Yield per ton of green garbage		Garbage treated by reduction per capita (pounds)
					Grease (pounds)	Tankage (pounds)	
Baltimore ^a	1928	67,576	.....	.....	..	...	...
Boston ^a	1927	55,000	3,300	3,850	60	140	139
Bridgeport	1925	15,120	894	948	59	135	211
Chicago	1927	104,240	5,703	4,513	55	87	67
Cincinnati ^a	1928	63,904	.....	.....	..	...	...
Cleveland	1928	109,378	4,401	13,720	40	251	222
Columbus	1928	29,996	826	2,210	28	147	206
Dayton	1928	20,000	1,196	2,193	60	219	221
Detroit ^a	1928	174,400	10,464 ^b	21,454	60 ^b	246	261
Indianapolis	1928	33,281	1,679	1,563	50	94	168
Lorain ^a	1928	6,000	200	1,200	33	400	322
Philadelphia	1928	71,632	3,701	6,021	52	168	70
Pittsburgh ^{cc}	1927	109,312	4,531	16,390	41	300	329
Reading	1928	13,061	491	1,418	38	217	228
Rochester	1928	35,222	2,009	5,980	57	340	217
Schenectady	1928	7,200	379	1,050	53	292	155
Syracuse ^a	1928	24,000	1,680	4,320	70	260	243
Washington	1928	72,646	3,156	.....	43	...	269
Total (16 cities).....	....	1,011,968	44,610	86,830	..	...	...
Average .....	....	.....	.....	.....	51	197	157

* Source: Data obtained by correspondence. Population as of midyear 1927, *Statistical Abstract of the United States*, 1928, p. 43.

^a Operated by private interests, under contract with the municipality.

^b Estimated at rate of 60 points per ton of green garbage.

^c Combined data for two reduction plants.

^d As explained in the text, the full amount of recoverable tankage was not processed in a number of the plants.

on yields of product, it would seem that the smaller cities compare favorably in operating efficiency with the great urban centers.

Table 5 (p. 101) shows that in 1912 the production of garbage grease was 30.4 million pounds, rising to 65.2 million in 1917 and receding to 53.5 in 1918. From 1919 on, garbage and house grease were reported together. In 1919 the combined figure was only 50.8 million, with a progressive increase in subsequent years to a record output of 93.3 million pounds in 1927. Of the combined figure for 1927, about 50 million pounds was garbage grease, according to the data in Table 21, compared with 65.2 and 53.5 millions in 1917 and 1918, respectively. Evidently municipal reduction has been losing ground. It is plain, however, that in garbage there is an immense potential source of grease and tankage, which may some time in the future be salvaged should the price levels of these products rise or should the methods of reduction be improved.

However, unless current trends change, the rendering industry is likely more and more to take the richest materials away from the municipal reduction plants and thereby make their operations progressively more unsatisfactory. It is possible, of course, that here and there this tendency may be checked by municipal ordinances. As for hog feeding, its future effect upon municipal reduction is not so easily assessed, as will become evident in the next chapter.

CHAPTER XI

FEEDING GARBAGE TO HOGS

On a large number of farms hogs are fed on garbage, swill, and offals collected from various sources in near-by cities and towns. Under the conditions now existing in many sections, there is a considerable economic advantage in disposing of garbage by feeding to swine. The obvious economy of this method, compared with any other available to the smaller cities, recommends it to city officials despite objections that are made by urban dwellers to cartage of such wastes through the city streets. To farmers or feeders such utilization is not without certain disadvantages: it involves a somewhat specialized type of feeding and does not produce the best quality of product; it requires a greater expenditure of labor, in maintaining premises in a sanitary condition, for example; losses are caused by glass, steel, and injurious foreign materials; and there is danger of infection from hog cholera. Nevertheless, garbage is a cheap and abundant feed. It is considered a balanced ration, requiring no supplementary feeds, although grain is frequently fed to obtain more rapid gains. While it varies considerably in feeding value, 50 pounds of average garbage will produce one pound of pork. The materials that the animals do not take are plowed under for fertilizer. The advantages of feeding kitchen wastes are more pronounced in sections where feed is relatively scarce and high priced, as in the New England and Pacific states and in parts of the South.

The extent of the practice naturally tends to vary with prices of hogs and feedstuffs. In view of the rise in the domestic population and decreasing per capita supply of

agricultural land, it is evident that the trend, other factors aside, is toward an increasing use of wastes of this kind. A substantial and sustained rise in prices of either swine or feed, if it should occur, would tend greatly to increase the feeding of animal by-products.

That such feeding is now extensive is common knowledge. Swill trucks and wagons are a familiar sight in many cities. A great deal of garbage is fed in the environs of small cities and towns; and it is evident that here, where renderers are not operating and the disposition of wastes is relatively costly, disposal by feeding has many advantages. Quite generally also in the large cities, even those with municipal reduction or incinerating plants, a considerable part of the waste is collected by feeders.¹ These contract for the large accumulations of waste from hotels, restaurants, hospitals, and so forth. In some cities garbage is collected by the municipalities, brought to a central point, and there transferred to the farmers' wagons. In others, such as Los Angeles and St. Louis, all garbage (including that of hotels and restaurants) is taken by a single stock farm, under contract.² Frequently, too, small slaughterers or retail butchers who are not in a position to work up offals, feed them to hogs or sell them to hog feeders. In areas not served by renderers, in the South, for example, this is a common method of disposing of slaughterhouse offals.

In 1916 it was reported that 200 of the 544 cities with a population of between 10,000 and 100,000 disposed of their garbage by feeding it to hogs; so also did 20 of the 66 cities with a population in excess of 100,000.³ Of course

¹ It is doubtful whether in the aggregate the total fed to hogs exceeds that processed in the municipal reduction works. While such plants are not many, they are located in the great cities, and each treats large quantities of material.

² Such stock farms are usually located many miles from the city limits. The St. Louis garbage feeding station is on an island, and the garbage of Los Angeles is shipped 60 miles.

³ U.S. Food Administration, *op. cit.*

this may have been a temporary situation, arising from high war prices of feed and a great expansion in pork production. Similar data are not available for later years. However, cities such as Omaha, Kansas City, St. Louis, St. Paul, and Los Angeles are now delivering such waste to hog farms under contracts varying in their terms. A considerable number of smaller municipalities have adopted this method. According to the report of an official investigation of the situation in Massachusetts, in the cities and towns of that state disposal by feeding to swine is the chief method, and, except in a few of the larger cities, practically the only method employed for the disposal of garbage. On account of the high price of pork and grain feed in New England, garbage is usually valuable for feed, and for this reason there is little difficulty in so disposing of it. Another reason for the ready sale of such material is its value for fertilizer. A mineral fertilizer is less efficient for some soils than animal manure, and the problem of obtaining such fertilizer was stated to be a serious one to farmers throughout the state.¹

To the feeding of garbage, however, there are objections upon the part of nearly every interest concerned. Some of these objections are serious; others may readily be met by various alterations in present methods of operation. Garbage-fed hogs produce soft and flabby pork and soft lard. For this reason the meat-packing industry does not wish to see the practice grow. It feels that there are now altogether too many soft hogs as a result of certain kinds of feed and from animals coming off green feed. Such animals produce relatively undesirable carcasses and generally sell at a price discount.² This diffi-

¹ Commonwealth of Massachusetts, *op. cit.*, p. 17.

² Dealers prefer to sell firm pork products because they hold their shape better, cut up better, and have a more attractive appearance. Lard from soft hogs is of such consistency that it will not harden even in the refrigerator. Farmers suffer a reduction in price on soft hogs, which averages around 2 cents

culty, however, could probably be met by finishing off the animals with supplemental feed. Likewise, hog cholera may be avoided by the usual preventive treatment with serum. Apart from the softness of the pork and lard produced by such feed, there is the question as to the wholesomeness of the meats. Garbage is usually a sour and unclean feed. Upon the wholesomeness of meats so produced there is little information, although it is urged that the feed of poultry and shellfish does not affect the quality of such foods.¹ It is but natural for packers and equipment manufacturers to oppose the feeding of garbage to hogs.

The objections of city residents to the odorous passage of swill wagons are frequent. It would seem, however, that these could largely be met by requiring the use of water-tight and covered wagons or trucks. Garbage feeding stations must also be located at a considerable distance from the city limits, since such stations create a nuisance. With the extension in the area covered by the large cities, however, the cost of cartage tends to rise. And finally, reduction works are usually opposed to the collection of garbage by feeders, since the latter take the most desirable classes of refuse (from hotels and restaurants) and tend to make reduction unprofitable. Mainly for this reason, several cities prohibit such collection or impose prohibitive wheel or license taxes.

Sanitary engineers differ concerning the merits of this form of garbage disposal. Some incline to the view that this plan is not practicable for towns of over 10,000 inhabitants because of the difficulty of maintaining in clean or sanitary condition the premises where the hogs are

per pound. Hankins, Ellis, and Zeller, *Some Results of Soft-Pork Investigations. II* (U.S. Dept. of Agriculture Bulletin 1492), February 1928, p. 2.

¹Virtually no raw pork is consumed in the United States. Pork is here universally cooked before it is eaten, and hence there is scant likelihood of infection from trichinosis. Under federal inspection no article that might be eaten without cooking (e.g., some types of sausage) is permitted to contain unsterilized pork.

kept, and keeping the stock in good health. One hundred animals will eat a ton of garbage a day; twenty to thirty pigs are required for every thousand of population. Therefore, the number of hogs necessary to dispose of the garbage of a city of any size is very large, and difficulties of sanitation rise rapidly with increasing number of hogs. Yet it would seem that other methods of disposal might be used to supplement feeding; and if an ample water supply is available, water may be provided for the animals and for cleansing the premises several times a week. Proper construction of buildings, it is stated, would reduce flies and other vermin. It is noteworthy that cities such as Omaha and Los Angeles report that feeding is a satisfactory and relatively inexpensive method of disposing of city garbage. Thus of Omaha it is stated, "Our garbage is let out on contract to hog feeders, which plan is proving very successful." Other large cities which utilize this method are St. Louis, Denver, San Francisco, Los Angeles, St. Paul, and Topeka. The methods in use at Los Angeles merit more than passing consideration.

In 1914 the city of Los Angeles erected a costly reduction plant for the disposal of garbage. After a brief period of operation by the city it was taken over by private enterprise on a ten-year contract, the contractors paying the city 51 cents per ton for the material delivered at the plant. After several years of apparently successful operation the plant was abandoned, owing to the low post-war prices of the recovered products. All the garbage is now delivered to a stock farm, which pays the city 60 cents per ton for the material f.o.b. cars at Los Angeles, and pays, also, \$1.80 per ton for transportation to the hog ranch 60 miles away. The waste and material not consumed by hogs is used as fertilizer on adjacent citrus lands. The ranch supports 40,000 hogs, fed nothing but city garbage, except for special feed given sows at farrowing time. About 19 pounds of the kitchen refuse is fed

daily to each animal; the gain in weight is 40 to 80 pounds per ton of garbage. It is reported that it requires several generations of hogs to develop animals best adapted to this form of feeding. Grain-fed animals brought to this ranch do not do as well and are more subject to disease.

A municipal ordinance, upheld by the courts after litigation, restricts collection of garbage to the city's collectors. This includes the refuse from hotels and restaurants, which is much higher in value than the average residential waste and could otherwise be sold by such institutions to renderers or hog feeders. Such material brings up the average quality of the garbage, and makes the city contract more attractive. The municipal ordinance requires, also, the segregation of garbage, defined as the refuse from the preparation and consumption of human food. A contractor also pays the city \$502 per month for delivered non-combustible refuse.¹

What volume of kitchen, household, and slaughterhouse wastes are now utilized in this way it is impossible to say. There are no quantitative data. The situation is complex. Considerations of sanitation, public regulations, prices of hogs and feeds, competition of rendering and reduction plants—all these factors so influence the situation as to render of scant value any opinion as to the future of this practice or as to its desirability. It is apparent, however, that garbage now unutilized may be regarded as an immense potential supply of cheap feed, much of which is now being incinerated or dumped. At the rate of a "production" of 250 pounds per capita, the total supply foots up to some 30 billion pounds a year, or, allowing for moisture, approximately 3 or 4 million tons of solid matter (grease and tankage).

¹ From R. W. Stewart (Board of Public Works, Los Angeles), "Garbage Collection and Disposal at Los Angeles," *The American City*, April 1928, XXXVIII, 155-59.

CHAPTER XII

ANIMAL BY-PRODUCTS: MARKETS AND CONSUMPTION

THE BACKGROUND

In the preceding chapters the various sources of animal by-products and waste, and the character and status of the salvaging industries, have all been presented in some detail. Chief attention has been given to inedible animal fat. It is the main product, and the only one for which we have even fairly adequate data; and in perhaps no other way can so close an approach be gained to the whole problem of wastes and salvage. It has been shown that the organization of meat and salvaging industries, their methods of production and marketing, are all profoundly influenced by a complex body of federal, state, and municipal regulations; that these regulations, primarily designed as sanitary measures, have had serious, unforeseen, and apparently avoidable economic consequences. The production of inedible animal fats, it has been noted, has grown very rapidly, and at a much faster rate than have slaughter and meat production. Most of the increase has been in tallow. Yet the slaughter of tallow-yielding animals has on the whole remained stationary or declined.

On the surface, these facts appear to be incongruous. Breaking down the statistical data for a clearer view of the situation, we find that the production of inedible fat by slaughterers and meat packers has increased but slightly; that it varies primarily with the volume of slaughter and secondarily with the percentage of con-

demnations for disease. It is the rendering industry that has contributed the bulk of this increment in the output of inedible fat. This industry registers in a curious way sundry changes in the economic life of the nation. Essentially limited to the supply of raw materials locally available, it has profited by the concentration of population in urban centers, by changes in food consumption (making for greater by-product and waste), by the development of local slaughter, motorization and better roads, and so on. In the case of the rendering plants, the rising production has involved tallow much more than grease, and this appears to be in part at least the result of the present divided system of regulation, perhaps an indication of a trend away from federal inspection.

As to garbage disposal by reduction, the total output of fats and fertilizers from this source is relatively not large, and the trend here is not clearly defined. Its possibilities seem to be large if the methods of production are improved. The fact that it is essentially a municipal project has retarded the development of reduction. The usual alternative, incineration, is of course essentially wasteful, although under certain conditions it may be less costly. However, with the improvement in the methods of reduction already foreshadowed, it is probable that the chief competition to this system of handling city garbage will come from feeders. The feeding of animal wastes and city garbage to hogs is extensive, but the future of this practice will depend upon prices of feeds and hogs, and upon sanitary regulations. Several large cities, and many small ones, have adopted this method; and feeders also collect wastes rather generally from hotels, restaurants, and the like, even in cities where reduction or incinerating plants are in operation.

Thus far the discussion has run largely in terms of production—the raw materials, processes, problems, products, and the like. These facts do not explain why these

growing increments of raw materials are being utilized. There remain to be considered the factors of demand—markets, trade, prices, consumption, and so forth—and the outlook for the future; and further, the questions of public and business policy that arise in relation to these industries. These questions will now be considered in turn.

IMPORTS, FOREIGN COMPETITION, AND TARIFFS

Factors of demand have been important contributors to the growth of the salvaging industries. First of all, it is to be noted that there is a large and growing world trade in animal by-products. The rising volume of imports into the United States indicates a growing shortage here. The foreign trade in the various animal by-products, since 1922, is given in detail in the Appendix (pp. 320-25); Table 22, below, presents the imports for consumption for 1927, the latest year for which such data are available.

TABLE 22.—UNITED STATES IMPORTS (FOR CONSUMPTION) OF PRODUCTS FROM ANIMAL OFFALS AND MEAT WASTES, CALENDAR YEAR 1927*

Commodity	Quantity (thousand pounds)	Value (thousand dollars)
<i>Feeds and fertilizer</i>		
Tankage	49,284	847
Dried blood	26,864	696
Other nitrogenous materials	120,124	1,195
Bone phosphate (bone meal and ash, and animal carbon)	122,273	1,541
Prepared fertilizer mixtures	14,020	232
Other substances used only for manure.....	82,271	668
Total	414,836	5,179

* Compiled from *Foreign Commerce and Navigation of the United States, 1927*; exclusive of hides and skins, leather, wool, and by-product meats.

INEDIBLE ANIMAL FATS

TABLE 22 (Continued)

Commodity	Quantity (thousand pounds)	Value (thousand dollars)
<i>Inedible animal fats and oils and derivatives</i>		
Beef tallow	10,855	787
Mutton tallow	2,053	138
Stearic acid	1,022	106
Oleic acid or red oil	79	7
Other animal oils, fats, and greases.....	145	11
Wool grease, crude	9,010	280
Wool grease, refined	1,917	150
Glycerin, crude	14,944	2,215
Glycerin, refined	8,339	1,705
Total	48,364	5,399
<i>Bones, glue, gelatin, and similar products</i>		
Unmanufactured bones	138,368	1,686
Hoofs, horns, horn strips, and tips.....	744	64
Glue stock, hide cuttings, etc.	43,372	1,845
Glue and glue size	9,145	692
Manufactures of glue and glue size.....	17	6
Gelatin, edible	2,479	484
Gelatin, inedible	1,435	759
Manufactures of gelatin	564	404
Bone black, bone char, blood char.....	481	8
Total	196,605	5,948
<i>Other products</i>		
Sausage casings	20,755	15,832
Bladder integuments, etc.	390	180
Rennets	139	88
Total	21,284	16,100
Grand total	681,089	32,626

In 1927 the imports into this country of products recovered from offals, meat wastes, and the like, were valued at about 32.6 million dollars. This is equivalent to nearly 65 per cent of the reported value of product of the

rendering industry proper. The physical volume of imports was about 681 million pounds. Considering the magnitude of the domestic supply of unused raw materials and the growth in domestic production, these large imports are striking. These figures, it should be observed, are exclusive of animal by-products such as hides and skins and wool, which are among the principal items in the American import trade. The figures also exclude leather, by-product meats, and edible fats. Of the last, imports are small.

The first group in Table 22, animal feeds and fertilizers, totals 415 million pounds, valued at 5.2 million dollars. The chief items therein are tankage, dried blood, other nitrogenous materials, and bone phosphate. All these enter free of duty as "substances chiefly used for fertilizer." The second group, consisting of inedible animal oils, fats, and derivatives, totals more than 48 million pounds, with a value of 5.4 million dollars. The main item, glycerin, chiefly a by-product of fats and oils used in the soap industry, is derived in some part from vegetable as well as animal materials. The third group comprises unmanufactured bones, glue, gelatin, and similar products, and is related in character to the first group of feeds and fertilizers. It amounts to 197 million pounds, with a value of 5.9 million dollars. Lastly, imports of sausage casings, bladders, and so forth, were 21 million pounds, valued at 16.1 million dollars.

These large imports come from nearly every quarter of the globe. Taking these foreign products as a whole, the largest imports of the more advanced commodities, glue, gelatin, bone phosphate, and the fat and oil derivatives, come from Europe. The chief countries of origin are Germany, Great Britain, Belgium, and the Netherlands. Of bone phosphates India is the largest contributor. Of the raw or intermediate products (tankage, dried blood, animal fats and oils, sausage casings, unmanufactured

bone) the imports, in large part, as would be expected, come from the great meat-exporting countries, Argentina, Uruguay, and Australia. Canada also is an important source. China is one of the largest shippers of casings.

Thus far, however, foreign competition does not appear to have seriously affected the domestic by-product industries. Their inherent strength is indicated by the record of growth in the face of low import duties.¹ Most of the products, in fact, are on the free list. The by-product industries appear to have gained little benefit from the higher tariff policy inaugurated in the Emergency Tariff of May 1921 and extended in the act of September 1922, which now is in force. To the extent that the high general level of tariffs has disproportionately increased costs, these industries have in fact been adversely affected by the present tariff policy. The tariff upon tallow is one-half cent a pound; upon greases, horse oil, and neatsfoot oil it is 20 per cent ad valorem. Compared with the general level of the tariff, these are low or moderate rates. Other products of the renderers are upon the free list. Hides and skins, bone, horns, and the like, casings, bladders, rennets, hide cuttings and all other glue stock, bone meal, bone ash, and dried blood enter free of duty. So also do tankage and cracklings, under a provision for "all other substances used chiefly for fertilizer." The detailed import duties upon these products—in the act now in force, as well as in the two preceding tariffs, 1909 and 1913—are given in the Appendix (pp. 330-34).

These low duties are noteworthy, since the past decade has been one of steadily rising tariffs. The reasons for the seeming inconsistency are evident. Renderers are usu-

¹ Producers of glue and gelatin from animal wastes seem to be in a less favorable situation. See U.S. Tariff Commission, *Glue, Costs of Production*, March 23, 1928 (Preliminary [Mimeographed] Statement of Information Obtained in the Pending Investigation, as Ascertained Pursuant to the Provisions of Section 315, Title III, of the Tariff Act of 1922).

ally small producers, widely scattered, and relatively inarticulate. The national packers, controlling foreign subsidiaries as well as some large domestic plants, have hitherto taken little part in the tariff controversy; after all, they are primarily concerned with their manufacturing margins. Finally, it has appeared to be in the interest of agriculture to maintain low rates on fertilizers and concentrated feeds. In the absence of an organized or effective demand for higher rates, legislators have been eager to improve the appearance of the tariff acts by retaining such commodities upon the free list, or by assessing low rates. On glue and gelatin the rates are much higher, but producers of these products were active in seeking protection.

On the whole, however, foreign competition in these products appears unlikely to increase materially. So far as the great meat-exporting nations are concerned, their surplus of animal by-product is primarily an incident of slaughter. It is true that these countries possess only a limited domestic market for offal products. Their manufacturing industries are relatively small and backward; and their agriculture, of the characteristic extensive type, makes little use of mixed feeds and fertilizers. However, the volume of offal products in these countries is conditioned by the international demand for meats. Owing to the relatively small and scattered population, the amount of recoverable waste from distribution and consumption appears to be limited. Additional exports move from many other regions, some of them importers of meat.

The industrial countries of Europe export the more advanced products, part of the raw material for which is imported. There an intensive use is made of offals and by-product. But these countries are upon a net importing basis for animal products. The demand of the great industrial regions for animal by-products is increasing more rapidly than their demand for meats. Similarly, it is un-

likely that exports of animal products from such countries as China and India will substantially increase.

DEMAND FOR TANKAGE AND CRACKLINGS

Be all this as it may, the trend of domestic consumption is clearly indicated by the rapid increase in production and by the heavy imports. A more intensive agriculture is using increasing amounts of mixed feeds and fertilizers. The United States is the world's largest market for fertilizer, and the demand for organic ammoniates and bone phosphates seems likely to increase. A growing proportion of the domestic supply of tankage is being diverted from fertilizer to the higher-priced markets for feed, the deficiency being made up by imports. More intensive and scientific feeding is expanding the use of animal feeds. Containing 40 to 60 per cent of protein, 3 to 10 per cent of fat, and considerable lime and phosphoric acid (since there is more or less bone in the product), tankage and meat meals are rich feeds, well balanced in composition, and highly digestible. They are extensively used to balance the feeding ration. Hogs make better gains when fed meat residues with corn than when corn alone is used. In the case of poultry, the opinion is generally held that egg production is increased by the supplemental use of crushed green bones and chopped meat residue.¹ Most of the animal feed goes to these two classes of stock; mixed with other feeds, it is also fed to cattle, sheep, and horses.

¹This view is questioned by some authorities. A correspondent states, for example, that a manufacturer of chicken feed ran some tests to determine the relative value of green bone, and of bone disintegrated by steam in the rendering process. These tests, it is informally reported, indicated that there is no feeding value in crushed green bone, but that disintegrated or steamed bone had a beneficial influence upon poultry.

INDUSTRIAL DEMAND FOR FATS

The world supply of animal fats falls far short of the growing requirements for fatty materials in the food and non-food industries. Excepting butter, such fats are essentially by-products of meat production, limited in supply by the output of and demand for meats. Partly because of this situation, the production of vegetable oils has immensely increased during the past four or five decades. The world production of vegetable oils is now 15 billion pounds, more or less,¹ and the bulk is consumed in Europe and the United States. Both are regions of deficient production, considering fats and oils as a class.

In Europe there is a large shortage of both fats and oils, for food as well as industrial uses. There the extensive substitution of vegetable oils for animal fats began much earlier and proceeded more rapidly, and a much larger proportion of vegetable oils is now used than in the United States. The American shortage, likewise general in character with the exception of lard and edible beef fats, is progressively becoming more acute in the wide field of industrial use.

Now while advances in the technology of refining and utilization have notably widened the uses of fats and oils, these developments have also served to shift industrial fats to the food industries. Either because of the character of the products, or because of the pressure of partially substitutable materials (mineral oils, waxes, rosins and the like), industrial consumers as a class cannot utilize the higher-priced fats and oils. In foods, custom, prejudice, appearance, and salesmanship usually play a more important part than prices or intrinsic merits of a product. The industrial demand for different fats and oils is

¹ The oil equivalent of the world production of oilseeds was about 17 billion pounds in 1927. (*Foreign Crops and Markets*, May 14, 1928, XVI, 693.) Not all of this material is processed for oil.

based upon their physical characteristics, component materials, and relative prices.

In short, the range of fatty materials available for technical use has been narrowed. At the same time, the industrial demand has increased much more rapidly than have the food uses, and it is, on the whole, a more varied and specialized demand. In the field of non-drying technical uses, wherein tallow and grease are by far the most important items of domestic supply, there has been a particular shortage of fats of good quality in respect to titre, color, and percentage of free fatty acids. It is true that the commercial development of the hydrogenation process, dating back to about 1912, has greatly lessened the general deficiency of hard fats. But the influence of hydrogenation has chiefly been felt in the field of edible products. Tallow and grease possess distinctive properties that limit the degree of substitution. Moreover, the hydrogenation process is as yet too costly and too technical for application to relatively low-priced industrial uses.

FAT REQUIREMENTS OF SOAP AND OTHER TECHNICAL INDUSTRIES

The characteristics of industrial use are illustrated by the demands of the soap industry, which remains the chief domestic outlet for inedible animal fats and is, besides, the chief non-food consumer of fats and oils as a class. In its search for supplemental materials the soap industry has been responsible for many if not most of the technical improvements in refining, bleaching and decoloring, deodorization, distillation, hydrogenation, and in the "splitting," graining, and pressing of oils and fats. These technical advances have also greatly widened the markets for inferior greases and tallows, no less than for edible animal fat.

Tallow is the chief constituent of toilet and flake soaps.

The latter must be hard if they are to "flake" properly. For such uses the American market demands a relatively large proportion of hard, white soaps. Tallow, with a titre of 40 to 45 degrees, usually produces a hard product, with a slow, close, and lasting lather. It imparts "body." Because of its hardness, and its slow and difficult lathering properties, tallow is supplemented by other fatty materials. Since coconut oil yields a quick, frothy,

TABLE 23.—CONSUMPTION OF OILS AND FATS IN THE SOAP INDUSTRY OF THE UNITED STATES, 1921-23*

Product	Million pounds			Percentages		
	1921	1922	1923	1921	1922	1923
Grand total	1,017	1,132	1,189	100.0	100.0	100.0
Vegetable oils	396	396	492	38.9	35.0	41.4
Animal fats and oils	550	682	640	54.1	60.2	53.8
Tallow	373	430	402	36.7	38.0	33.8
Greases	113	142	140	11.1	12.5	11.7
White	31	37	43	...	...	...
Yellow	32	37	39	...	...	...
Brown	30	43	41	...	...	...
Garbage	19	22	16	...	...	...
Bone	1	2	1	...	...	...
Tankage .....	...	1	...	...	...	...
Red oil	13	10	12	1.3	.9	1.0
Fish and whale oils	38	90	73	3.7	8.0	6.2
Miscellaneous	13	10	13	1.3	.8	1.1
Unclassified	71	54	57	7.0	4.8	4.8

* Data from U.S. Tariff Commission, *Certain Vegetable Oils*, Part II (1926), p. 168.

and unstable lather, of only fair detergent qualities, the two are widely used in combination. Softer oils are also added, because coconut oil tends to make the product brittle, or "crack" easily. Cottonseed-oil foots often replace both tallow and grease. The chief competitor of these

animal fats, however, appears to be palm oil. This oil produces a firm soap, with a close, greasy, and durable lather that is of indifferent quality for cold water, but lathers freely in warm. The use of palm oil in white or light-colored soaps is limited, since it tends to render the product too buff in color.

Hog greases make a soft soap, fairly soluble in cold water, and like tallow yield a slow, lasting lather. Like tallow, also, these are blended with other fatty materials. The odor and "off" color of many of these greases may usually be removed by bleaching and deodorizing, and they are extensively used in liquid soaps, as well as in the lower qualities of household soaps. Even garbage grease yields a good product if first changed into fatty acids and distilled. It is utilized chiefly by the larger producers, since a small plant rarely has the requisite equipment for distillation.

The demands of compounders of lubricants are as a rule less highly specialized than are those of the soap makers. Formerly, lubricants were exclusively solid fats, fatty oils, and liquid waxes such as sperm oil. Since the development of lubricants from mineral oils, such fats have become subsidiary materials, generally used in admixtures with mineral oils. Different classes of lubricants have been developed for the varied kinds of delicate and heavy machinery. The components of such mixtures are frequently regarded as a trade secret. The fats most commonly used in cup greases are horse fat, lard or lard oil, tallow, cottonseed oil, stearic and oleic acid. Fats are selected for properties such as hardness, melting point, consistency, and color.

These two industries, soap and lubricants, are the largest individual consumers of inedible animal fats. It has already been noted that tallow and grease, as well as derivatives, are used alone or in combination with various materials in a large number of other industries—in cos-

metics, in the leather and woolen industries, and so forth. The preparation of such fatty mixtures for different classes of industrial use is becoming a specialized business, sometimes known as the "oil products industry."

EXPORTS AND DOMESTIC CONSUMPTION

Differences such as the foregoing, in titre, quality, color, account for many cross-currents in the domestic and foreign trade in animal fats. Geographical factors are an additional influence; California ships tallow to Mexico at the same time that Eastern markets receive tallow from Argentina. The general trend, however, is clear. The peak of exports of "tallow" was reached in 1906 with shipments of 111 million pounds; the subsequent trend has been downward, exports being 17.5 million pounds in 1925 and 6.6 millions in 1927. These exports consist almost entirely of inedible grades,¹ and are largely offset by imports. The volume and value of the exports are given in detail in the Appendix (see Table VI, p. 320). The exports constituted about half the domestic production of the inedible tallow in 1906, and less than 2 per cent of the much larger output of 1927. Of inedible animal fats, the only other substantial item of export is a growing movement of "other animal greases, oils, and fats," which amounted to about 82 million pounds in 1927. It is probable that this consists of grease.² The bulk of these exports go to the Netherlands.

Upon the conservative assumption that both the ex-

¹ From 1925 on, the official figures are for "tallow," without any segregation of edible and inedible grades. Data for earlier years, however, indicate the great predominance of inedible tallow. Thus in 1924 exports of edible tallow were 988,644 pounds, and of inedible tallow 32,973,012 pounds.

² Fish oil, oleo, lard, tallow, lard oil, neatsfoot oil, stearic acid, red oil, and grease stearin are separately enumerated in the export figures of *Commerce and Navigation of the United States*, and are thus not included in this catch-all group of "other animal greases, etc." Grease is not separately listed; hence the assumption that it is the main item.

ported and imported tallow were of inedible quality and that "other animal greases, etc." is animal grease, the per capita consumption of inedible tallow and grease has risen from about 2.6 pounds in 1912 to 5.3 in 1925, and the total consumption of the two fats has more than doubled, from about 245 million in 1912 to 615 million in 1925.¹ Of all oils and fats combined—animal (including butter as well as fish oil) and vegetable, edible and inedible—the per capita consumption rose from 51.4 pounds in 1912 to 64.5 in 1924. Consumption of vegetable oils increased from 21.3 to 26 pounds per capita; of animal and fish oils from 30.1 to 38.6 pounds.² The net increase in total consumption was 2.4 billion pounds, and in per capita consumption 13.1 pounds. Deducting the questionable increase in lard, the rise in per capita consumption would be 8.8 pounds. This is mainly in fish oils (for soap and other industrial uses), in greases and tallow, and coconut oil. The rise in coconut oil was 2.4 pounds per capita, used chiefly in soap.

Accordingly, the domestic consumption of fats has risen much more rapidly in the non-food industries than in the food industries. With the large expansion in the domestic output of soap, virtually all of the tallow (about 400 million pounds) now goes to this use. Tallow constitutes about one-third of the 1.2 billion pounds of fatty materials consumed by the soap industry. About 140 mil-

¹ Using the official estimates of production. In 1912 exports of "soap-stock and other grease" were about 4.6 million dollars (quantity not reported). At 6 cents per pound, estimated, this would be 76 million pounds. A difference of one or two cents per pound would have little influence upon the per capita figure. Exports of other inedible fats totaled 41 million pounds in 1912.

² The figures for per capita consumption, 1912 and 1924, were taken from the report of the U.S. Tariff Commission, *Certain Vegetable Oils*, Part II (1926), p. 88. The figure for lard (11.5 pounds per capita in 1912 and 15.8 in 1924) seems rather doubtful. It is based upon the rough official estimates for farm and non-federally inspected lard, which are mere guesses. Such an increase, moreover, seems the less likely when consideration is given the large expansion in the domestic consumption of competitive lard compounds and cooking oils.

lion pounds of grease goes to the same industry; most of the rest, as elsewhere indicated (pp. 54-55), is fractionated for lard oil, stearic acid, and the like, and is extensively used in industry and is exported.

PRICES

In the Appendix (pp. 309-16) will be found a compilation of the average monthly and annual prices of the various grades of packers' and renderers' tallow and grease, as well as of garbage grease, since 1920. Prices of "domestic concentrated," garbage, and South American tankage are also shown. During the war the prices of these products reached unprecedented levels, two or three times as high as in recent years. The bottom of the post-war depression was reached in 1920-21, the next two years being characterized by well-defined upward trends. Since then the prices of fats and tankage show somewhat divergent tendencies. Below is given, in summary form, the average yearly wholesale price of representative grades of tallow and grease at Chicago in cents per pound:¹

Calendar year	Tallow (prime packers')	Grease		Palm oil, Lagos
		White	Yellow	
1921.....	6.4	5.9	4.2	7.4
1922.....	7.1	7.3	5.9	7.4
1923.....	8.2	8.4	7.0	7.7
1924.....	8.4	8.3	7.3	8.2
1925.....	9.7	9.8	8.9	9.3
1926.....	8.7	8.5	7.7	8.6
1927.....	8.1	7.7	7.0	8.1
1928.....	8.8	8.3	7.6	8.4

Wholesale prices of palm oil at Chicago are also shown in the foregoing tabulation, because it is to a considerable degree interchangeable with tallow in some of

¹ See Appendix, pp. 309-14.

its more important uses—in certain classes of soap. This oil enters free of duty. Imports of palm oil in 1921 were only 23 million pounds. Thereafter imports increased rapidly, the figure for 1928 being 169 million pounds.

The general level of tallow and grease prices has not materially varied from the level established in 1923. In that year prime packers' tallow, for example, averaged 8.2 cents per pound, and in the following two years moved irregularly upward, the average for 1925, 9.7 cents, being higher than that of any year since 1920. Prices receded in the next two years, to an average of 8.1 in 1927, with a recovery in the last year, 1928, to 8.8 cents per pound. The spread between the prices of representative packers' and renderers' grades, however, has narrowed. In 1921 prime packers' tallow, for example, sold for 1.5 cents per pound higher than No. 1 renderers' tallow, and by 1928 the difference was reduced to 0.6 cents per pound. Either the quality of the renderers' product has relatively improved, or changing methods of utilization have reduced the difference in value. Something approaching a seasonal trend is to be seen in the monthly quotations, prices as a rule being higher in the second half of the year. All these are quotations at Chicago, the principal market. Doubtless these are representative, for brokers and producers throughout the country usually receive frequent telegraphic advices concerning the course of the markets.

Grease prices follow rather closely the general trend of quotations for tallow. Here, too, is to be seen the same narrowing of the price spread between different grades.

Tankage prices show a much more notable increase. Garbage tankage, to be sure, has remained at about \$5.50 per ton since late in 1926. This quotation appears to be a nominal one, for the same price is reported month after month without change. For "domestic concentrated" tankage the average price, per unit of ammonia, was \$2.24 in 1921, rising to \$3.29 in 1923, receding in 1924, and

then advancing rather steadily, the average for 1928 being \$4.09 per unit of ammonia. A ton of domestic concentrated tankage containing 14 per cent of ammonia averaged \$31.36 in 1921 and \$57.26 in 1928. Thus prices of tankage nearly doubled during this period, while those of inedible fat rose about 50 per cent. The significance of this will be apparent when it is recalled that the yield of tankage from the average material is considerably larger in volume than that of fat. The residual meat and bone product is evidently becoming an increasingly important factor in the situation. It will be observed, also, that the "to arrive" price at New York of South American tankage is usually about 75 cents per unit of ammonia higher than that of the domestic product at Chicago. Differences in freight charges will not account for this difference, which presumably reflects superior quality of the imported product.

The record of advancing prices alone does not adequately reflect the betterment in the economic position of the animal by-product industries. Costs have evidently been reduced, for despite the substantial rise in wages the value of output per wage earner has doubled. More and better product is extracted from a given quantum of raw material; and this is notably true of tankage and cracklings, more of the value of which was formerly lost in the tankwater.

OUTLOOK FOR THE FUTURE

Inedible oils and fats face two kinds of competition. At the upper margin of price there is the potential competition of oils and fats that ordinarily go to food uses, as well as of the foots from the refining process. At the lower margin there is competition from a completely different field, the mineral oils. The substitution of mineral oils has been most extensive, of course, in lubricants; but such

oils also displace animal and vegetable fats in paints and varnishes, leather, and other uses. Rosins and gums replace fats to some extent in soap. Just as cottonseed, corn, and peanut oil have largely moved from the low-priced industrial uses to the higher-priced field occupied by butter, olive oil, lard, and cacao butter; so on the lower margin of uses the mineral oils and various "fillers" have tended, by actual or potential competition, to keep down the prices of tallow and grease. Because of the comparative stability in the supply of these fats, price fluctuations are chiefly the result of the shifting pressure of the various competing materials. Similarly, the price of tankage and cracklings is affected by that of oil cakes, by profitableness of the livestock and feed industries, and by fertilizer prices. Cottonseed oil and lard are regarded as the two main "barometers." In fact, producers of tallow and grease appear to attach more immediate importance to the price of these two edible fats than to shifts in production of inedible fats or tankage. This situation illustrates the mode in which diverse branches of the oils and fats industry are geared to a common economic wheel. It is a complex price-and-demand situation, an excellent illustration of the "inter-industry competition" with which business seems latterly to have become much concerned.

That the net influence of these forces of demand and supply has been favorable is indicated by the substantial growth in production, and on the whole by advancing prices. The supply of raw material, it has been noted, is essentially an incident of meat production and consumption, and correspondingly limited. The demand for animal by-products is increasing much more rapidly than the demand for or production of meats. There is little question that such a situation will lead to a further development of the salvaging industries, apart from the fact that the long-run trend of meat production is upward. The output of inedible animal fats and their joint products

seems likely to continue to increase for some time to come, although such expansion can come only slowly, chiefly through the installation of new plants in many areas not now served.

In the course of its further expansion the rendering and reduction industry faces a number of immediate problems, in respect to sanitary regulation, in technical efficiencies of production and marketing, in standardization of grades, and in organization. In such respects the business has not advanced as far as other groups in the oils and fats industries. This is a natural consequence of the small size and dispersion of its component units.

It should be noted that of the present supply of renderers' raw material a substantial proportion results from trade practices which may change, or from public regulations that may be altered. Neither of these changes seems likely to occur in the immediate future. For example, at present trade custom and the operations of the federal Meat Inspection Act are responsible for substantial portions of the raw materials. If the packing industry should abandon the custom of shipping beef, calf, sheep, and lamb carcasses with much edible fat attached, very large quantities of edible tallow and oleo stock would be added to the supply of these products, and the yield of inedible product from this source reduced. Growth in local outlets for edible by-products, as well as for oleo oil, shortening, and the like, may somewhat affect the supply of inedible grades. Modification of the Meat Inspection Act might have similar effects. As we have seen, one consequence of the act is that the bulk of the tallow produced outside of federally inspected plants goes to inedible uses.

Part of the edible tallow produced by the smaller interstate plants is of inferior quality and now goes to non-food uses. If refining under high temperatures, as is done in the case of vegetable oils, were permitted for

animal fats going into interstate and foreign commerce, it would add to the available supply of edible animal fat. Second, a larger increment to the supply would result from the admission into federal plants, under appropriate regulation, of raw fats (caul and leaf fats, for example) from approved city-inspected plants. If through a change in marketing conditions the meat packers more commonly "break down" carcasses, this also will affect the situation. It is reported that several are experimenting with the direct marketing of meat cuts.

CHAPTER XIII

SOME QUESTIONS OF PUBLIC AND BUSINESS POLICY

So far the discussion has run largely in terms of production, distribution, and consumption in different branches of the slaughtering and meat-packing industry, in rendering plants, municipal reduction works, and on hog farms. Of greater moment are the collateral problems affecting matters that are of broader public concern. Out of the mass of economic and physical facts respecting the animal by-product industries have emerged a number of problems of public welfare and public regulation. Such regulation tends to be static, progressively unsuited to the needs of dynamic industries. There are, also, a number of problems of business policy, the solution of which necessitates joint or co-operative action on the part of the producers and related interests. Such problems of public policy, as well as certain general problems before these industries, merit consideration in concluding this study. We shall venture also to indicate certain changes in procedure that seem to be desirable.

EFFECT OF ECONOMIC CHANGES UPON PROBLEMS OF MEAT INSPECTION

Of special moment are the economic and sanitary consequences arising from the independent and varying administration of meat inspection by the federal government, the states, and municipalities. More than two decades have passed since the enactment of the Meat Inspection Act of 1906. Although this Act may have been reasonably effective for the conditions of 1906, it seems

inadequate to deal with the problems of 1929. The intervening period has been one of singularly rapid change in the economic life of the nation; and because of their effect upon the livestock industries these far-reaching changes appear to call for a reconsideration of the present mode of regulation.

At the beginning of the century the United States was the world's largest exporter of meats and animal products. Quarantine and other restrictions, based upon sanitary considerations, threatened to destroy this trade. The importing countries demanded that the entire product of exporting plants be adequately supervised.¹ Such plants also did the bulk of the interstate business, and the combined interstate and foreign trade in meats was then of overshadowing importance. It therefore seemed sufficient to take jurisdiction over the entire output of plants in this trade, under the interstate commerce clause, leaving to the states the regulation of other slaughter, then scattered and highly localized. Moreover, it was not until 1909 that the first and only census of such local slaughter was made, so that even its former proportions were not clearly realized.

The conditions of 1929, however, are radically different from those existing during the early years of the century. In the first place, the United States has given up most of its export trade in meats. It is now on a net import basis for beef and mutton, although imports are still relatively insignificant. Exports of pork, while still large, have greatly declined; exports of lard alone have been maintained. Since 1900 the total domestic consumption of meats has probably risen over 5 billion pounds, or about

¹It is hardly to be questioned that quarantine restrictions were at that time imposed upon animal products of the United States as a move of masked protection. Certainly the rigor of application reflected more the interest of domestic producers than consumers in some of the importing countries. It is true, our inadequate system of inspection of animal products exposed us to restrictive regulations; but the prominence of our export trade also exposed us to such measures.

50 per cent, although per capita consumption has probably declined slightly. Accordingly, domestic markets have become relatively much more important. In the large intrastate market—other things being equal—the official plants are at an economic disadvantage. Federal meat inspection entails an inclusive supervision of the plant, increases the capital investment in plant and equipment, and enhances operating costs. With few exceptions local inspection is much less adequate, and a large part of the local kill is uninspected.

In the second place, the growth in number and population of cities has provided larger local or intrastate markets for the slaughter not subject to federal inspection. This local market has been further extended by improvement in methods and reduction in costs of refrigeration, by better roads and the motor truck, and by an increasing demand for fresh meats. At the same time the expansion in local dairying and farming, to supply the needs of the cities, has increased the number of animals locally available, and has brought to bear the protective influence of freight rates. Factors such as these have tended to decentralize slaughter. That at least one part of the "unofficial" slaughter, that in the local wholesale plants, has grown at a much more rapid rate than has the kill under federal inspection, seems beyond question. This expansion emphasizes the seriousness of certain economic and sanitary problems that have grown out of the divided system of regulation.

SANITARY ASPECTS OF PRESENT SYSTEM OF INSPECTION

It is not only in the economic situation that a marked change has occurred since 1906. The same economic and regulatory influences which tend to increase local slaughter under the present divided system of regulation also enhance the danger of transmitting contagious animal diseases. A different realization of the relation and

methods of such transmission seems to have come about. The federal statistics respecting condemnations in the official plants are not complete; but in all probability only a small proportion of the federally inspected slaughtering plants in the United States reveals the presence of diseases transmissible to man. Meats may be unwholesome or nauseous even if not diseased; and if sanitation of the packing plant is not adequate, infection may be carried from diseased to sound meats, or carried outside the premises by flies, bacteria, vermin, and the like. It is in the arrangements for sanitation that the unofficial plants are most defective. The percentage of animals found to be diseased, then, is not a true index of the need of adequate regulation. Where informed opinion differs with respect to the danger of infection, the public should have the benefit of the doubt. There seems to be no question that bovine tuberculosis, usually the most common cause of condemnation, is transmissible to man; also that animals subject to such disease represent a larger proportion of the kill of local plants.

It seems to be more clearly realized that the danger of transmission to livestock is great. It is indicated by stringent regulation upon the movement of livestock, feeds, hides, and other possible sources of contagion, and by quarantines against Argentine beef, and against foreign livestock. Annual losses on the farm from such diseases as tuberculosis and hog cholera have been officially estimated at around 150 million dollars; the federal and state governments are spending millions of dollars annually in control or eradication. In this campaign the Meat Inspection Act has proved to be an important adjunct. To a layman it would appear that a break in the chain of regulation, in local and farm slaughter for instance, may largely vitiate the entire campaign. The recurrent and severe outbreaks of animal disease may therefore be significant in this connection.

No other food industry is so closely and stringently supervised as the slaughtering and meat-packing industry; that is, where regulation is seriously undertaken. Indeed, by virtue of such regulation, where it is effective, meats are certainly more sanitary than many other foods. Moreover, although informed opinion seems unanimous as to the facts, for obvious reasons we have made no attempt specifically to substantiate the charges regarding the ineffectiveness of most local regulation. But unless, as in federal inspection, competent officials are present to make ante-mortem and post-mortem examination, and to supervise details of production, large opportunities for subordinating public to private interest would appear to exist. It should be borne in mind, also, that the margin of profit in slaughter is not large, and the condemnation of two or three cattle a week would severely reduce the profits of a small slaughterer.

Under the pressure of competition and the desire for profits the adulteration and misbranding of food products has been frequent and extensive in the past.¹ The need of regulation is indicated by the record of cases under the Food and Drugs Act and under the Federal Trade Commission Act. The feed and fertilizer industries are now also closely regulated. For such purposes it has been the practice of the federal government to take jurisdiction under the interstate commerce clause of the Constitution. Problems arising from lack of a single responsibility for regulation are therefore not confined to livestock and meats. The difference is primarily one of degree. It is generally sufficient to inspect other foods in the course of their distribution. The apparent condition of meats does not of necessity indicate freedom

¹ Occasionally the press carries reports of proceedings against individual concerns for the sale of meat from condemned animals, with or without the collusion of an inspector. It is difficult, however, to obtain convictions because under the law it must be proven that the defendant *knowingly* sold meat that is diseased.

from disease, nor are the problems of contagion comparable.

ECONOMIC CONSEQUENCES OF PRESENT SYSTEM

The present system of multiple regulation, then, has certain sanitary consequences; it entails, also, certain economic losses and wastes—in the handling of by-products, for example. Other serious results are deserving of note. Does the Meat Inspection Act tend to maintain the present stratification of the slaughtering and meat-packing industry, so far as interstate and foreign trade are concerned? Only a plant that does an interstate business may obtain federal inspection; conversely, no plant may do an interstate business unless it has such inspection. How then may a local slaughter expand into a national trade? It is true that regulations appear to be reasonably applied; opportunity is given a slaughterer to develop an interstate trade. Nevertheless, federal inspection is costly, and a substantial volume of interstate trade must develop within a reasonable period to warrant federal regulation. Now the business of an individual plant of this kind grows slowly; it requires time, perhaps years, to gain an interstate trade in competition with established meat packers. The transition from a local business to an interstate status now seems to demand a large and abrupt change in policy, personnel, and operations which such a concern may not care or dare to make.

It appears, also, that a bona fide intrastate slaughterer compelled to operate under local regulation is penalized by the present system through no fault of his own; his markets for by-products are severely affected, and part of his trade demands the "U.S. Inspected and Passed" stamp. That local slaughter has grown in the face of such conditions is significant of the force of the changes that the meat industries are undergoing.

Furthermore, the fact that much of the inspection by states and municipalities is less effective than that of the federal government introduces artificial economic conditions into the meat trade, the full significance of which it is very difficult to evaluate. Jointly with the exclusion of local slaughterers from the large interstate trade, it must create 48 or more marketing zones, both for livestock and meat foods, wholly unnatural in character. The local slaughterer must dispose of his meat output within his zone in competition with the interstate packers; his by-product outlets are limited, and he must make a price on his lard, in the face of increasing competition of vegetable shortening, that will move it as lard, or else sell it for white grease. He cannot ship edible fats beyond the confines of a state, and a substantial part of other edible product must go to lower-priced industrial uses. Without question this zoning of markets and the limitations upon the use of by-product must exert an influence upon the prices locally paid for livestock. There is considerable "play" in such prices for meat animals; grades and shipping conditions do not permit of the close adjustment to prices in the great markets that obtains in such products as wheat.

Moreover, a small producer must have a local market for meat animals. For farmers who have only a few head of stock to sell and for some classes of dairy and unfinished stock that will not bear costs of transportation to the great centralized markets, the local slaughterhouse furnishes virtually the only market. Doubtless the situation must have an adverse influence upon prices of livestock, though it would be difficult to show this statistically.

REMEDIES

It is a question whether such a state of affairs is in the economic interests of the country. It may well be, however, that it is part of the price that must be paid for

safety in at least a part of our meat supply and for reducing losses from disease on farms and range. Since an increasing proportion of the country's slaughter is being done in plants not subject to federal inspection, the situation is becoming worse rather than better.

Unfortunately, it is difficult to see how the situation can be remedied by federal legislation. The Constitution does not give the federal government the direct police powers that are necessary. It has endeavored to meet the situation indirectly through the interstate commerce clause, and, as is evident, it has succeeded only in part. It might take jurisdiction through the taxing power; and the tax made small enough to lay no burden upon the industries or the public. Such a tax to cover costs of inspection is in fact assessed by states and municipalities. For federal inspection, on the other hand, no charge is made. Its cost, amounting to 7 cents per animal (1 cent per 26 pounds of dressed meat and lard), is defrayed from federal appropriations. The tax upon oleomargarine presents some points of similarity. In the light of recent decisions of the Supreme Court, for example, on the Child Labor Law, it may be doubted whether an act imposing a nominal tax for the purpose of taking jurisdiction rather than for the purpose of raising revenue would be held constitutional. Moreover, this would leave out of consideration the practical difficulty of supervising a multitude of small plants. At present the only hope of uniform meat inspection for a considerable portion of the people lies in improvement of state and local inspection. And this, unfortunately, seems a long way off.

Perhaps a preliminary to adequate sanitary control of local slaughter and packing, especially in the smaller cities and towns, would be the establishment of co-operative or municipal abattoirs. This would concentrate in one establishment the killing operations of a number of butchers, facilitate and simplify supervision, and make

available a sufficient volume of by-products to render better utilization possible. It might be combined with co-operative production and marketing of by-products. The municipal abattoir system is in successful operation in certain European countries and in Argentina. It has been tried in a modest way in several small American cities. Co-operative concerns for the handling of the by-products of a number of small butchers are in successful operation in a few localities. The multiplication of such concerns would seem to be in the public interest; they would give the renderers strong competition.

COMMENT ON SOME PHASES OF FEDERAL MEAT INSPECTION

The preceding discussion has dealt with some sanitary economic aspects of the divided responsibility for meat inspection. Important details of federal meat inspection—or the Meat Inspection Act of 1906 itself when such regulations merely carry out the specific mandate of the law—likewise seem to need reconsideration in the light of the technical and economic developments of the past two decades. It may well be that in some respects the regulations unnecessarily retard the development of the meat industries.

The regulations with respect to correct labeling, for example, present some suggestive considerations. It has been remarked that in edible animal fats it is the process that connotes the general grade or quality; e.g., kettle-rendered lard, neutral lard, steam lard, oleo stock, and so forth. In vegetable oils the grade or quality is determined by the characteristics of the oil rather than by the method of production. Now the federal regulations tend to maintain the historical trade classifications based upon processes long in existence. A kettle-rendered lard must be kettle-rendered; “country” lard must be lard made on the farm (although packers are permitted to sell a “country-style” lard), and so forth. The advances in fat-and-oil

technology have made it quite possible to achieve the same qualities by different and perhaps cheaper methods. Changes in process, however, are inhibited by the regulations, which thus tend to render the industry static. The same situation exists with respect to certain types of meats. It is true that the identical product, made by a different process, may be sold under appropriate labels; but this is substantially equivalent to the introduction of a new product. It is a costly and difficult task to change the established conditions of demand in food products.

Closely associated, in effect, are the limitations upon the refining of animal fats. Indeed, the restrictions upon the manipulation of animal fats derived by slaughter of meat animals, on the one hand, and the absence of such restrictions upon vegetable oils and milk fats, on the other, present some curious inconsistencies.

Contrast, first, the status of edible animal fats and vegetable oils, when both are made from sound, uncontaminated, and undecomposed materials. The refining of edible (rendered) animal fats derived by slaughter of sound animals is limited by the regulations with respect to correct labeling, already cited, and by other regulations which limit such refining to treatment with bicarbonate of soda or fuller's earth, the primary function of which is to improve the color of the fat. The refining of vegetable oils is not restricted. Nor are the reprocessing or refining of cheese and refining and coloring of butter limited by sanitary regulation.

Contrast, next, the status of animal and vegetable oils when both are made from raw material which was originally sound, uncontaminated, and undecomposed, but has undergone decomposition; and consider, also, the related case of a fat or oil, originally sound and wholesome, which has become rancid or undergone decomposition under the influence of micro-organisms introduced since the original preparation. The rancid or decomposed slaughterhouse

fat, or the slaughterhouse fat made from rancid or decomposed materials (although sterilized in the process of extraction) may not go to food uses and it may not be refined for food use. On the other hand, the rancid vegetable oils, sour or rancid butterfat and rancid butter and cheese may all be deodorized, neutralized, refined, or reprocessed with little or no restriction.¹

Our final illustrative case presents a different, and perhaps more logical, type of restriction, that on slaughterhouse fats derived from contaminated or diseased animals, primal parts, or viscera. In the process of extraction the animal fat is subjected to high temperatures and is thereby sterilized. Such fat may not legally go to food use, nor be refined for food use. This is probably due to a variety of considerations: the psychology of repellent origin, distrust of the technique of bacteriological sterilization, and fear of the presence of chemical poisons carried over from the diseased animals. For vegetable oils there is no analogue to this case. The situation with respect to butterfat is somewhat complex. Much butter and cheese are made from surplus market milk and cream, produced under the inspection and regulation of the different municipalities. The raw material for the bulk of the butter and cheese, however, comes from uninspected dairy animals. Many of these are now being tested in connection with the tuberculosis eradication campaign; and in any event, probably the comparative absence of regulation is here relatively not important.

¹ We are not here concerned with the adulteration of foods. The production of "filled" cheese, and "filled" milk or cream (wherein butterfat is replaced by vegetable oils or other foreign fat) has been stopped by prohibitive special taxes and other restrictions. It should be noted, however, that renovated butter is subject to a tax of $\frac{1}{4}$ cent per pound and is produced under regulations of the Treasury Department. Such renovated butter should not be confused with ordinary centralizer or other butter made from sour cream or butterfat. The great bulk of the domestic butter is made from sour or fermented cream, and is, of course, a wholesome product. It is the apparent inconsistency in the point of view with respect to slaughterhouse and other fats that we are here considering.

It is worthy of note that, almost the world over, methods of refining vegetable oils drawn from the more or less decomposed raw plant materials from which these oils are derived are in operation, which, if applied to certain of the inedible animal fats and oils, would result in products bacteriologically sterile if repellent in primary origin. When copra decomposes, the process includes putrefaction of the protein, fermentation of the carbohydrate, and cleavage of the fats, under the combined influences of autogenous enzymes and extraneous micro-organisms. The decomposing material offends the senses and is thus repellent; but it is devoid of association with disease of the coconut that might be conveyed to man, though of course the ingestion of decomposed coconut would produce what is commonly called ptomaine poisoning. In the animal fats and oils we have the factor of possibility of pre-existent disease. The decomposition may be comparable in the two cases from the sanitary, chemical, and bacteriological point of view; but in the inedible animal fats and oils, there is the repellent feature of pre-existing disease of the animal, which is absent in the vegetable fats and oils. Even though the refined animal fats and oils are, from the standpoint of health and sanitation, identical with the refined vegetable fats and oils, this difference persists in the mind of the consumer, or would be revived if animal fats and oils derived from such repellent sources were offered for human consumption. Much depends on the point of view; to certain groups in India all animal fats and oils are repellent; to Americans all animal fats and oils are repellent, despite acknowledged sterilization, if there is any suspicion of pre-existing disease in the animal. In Europe exists the tendency to place more faith in the refining processes and to be less solicitous about the derivation.¹

STATISTICS OF SLAUGHTER, MEAT PRODUCTION, AND CONSUMPTION

A repetition of the special census of retail slaughter, and the resumption of reports upon custom and co-opera-

¹ Paragraph contributed by Dr. A. E. Taylor.

tive slaughter, are essential to an informed view of the present situation. It is important, also, to obtain some notion of the sales of farm meats, which are uninspected. In 1909, the only year when a retail census was made, this kill was very large, aggregating over 13 million animals. This census bears internal evidence of being an approximation. In 1914 and 1919, the only years when custom slaughter was reported, the kill was 4.3 and 3.5 million head, respectively. What the trend has been in other classes of unofficial slaughter is entirely conjectural; we know merely that the local wholesale (non-federally inspected) kill has increased from about 4 million to 8 million head. Not until current statistics of the Census Bureau and of the federal Department of Agriculture with respect to slaughter and meat production are materially improved, can a clear view of these developments, of importance to the industries affected and the public, be obtained. To such an extension or betterment some important interests appear to be opposed, upon the ground that an excessive burden is already imposed by the statistics required by federal and state governments. Nevertheless the present data are in many respects misleading or inadequate, and the public interest appears to be clear. Until we are thus equipped, many of the inferences regarding important trends and facts, although in the main confirmed by informed opinion, will remain subject to controversy.

Adequate statistics of this sort serve many important uses. They affect the course of the markets, and are used by industry in determining trade policies. They are employed for administrative and regulatory purposes, in economic and dietary studies, and the like. It is sometimes suggested that the trade associations might develop the requisite organization. However, it is obvious from the actual or potential uses of such data that they cannot properly be delegated to an interested group.

DISPOSAL OF GARBAGE BY REDUCTION AND FEEDING

Questions relating to the collection and disposal of city refuse are among the more pressing problems before the municipalities. Kitchen waste or garbage is one of the most important classes of such refuse, not only by reason of its volume and content of recoverable products, but also because it decomposes rapidly and quickly becomes a serious nuisance. The solution of the problem of collection and disposal involves considerations of engineering, sanitation, and economics. Some general principles have been evolved in the solution of the problem; these, however, are modified by local conditions. It has been noted that widely different results have been achieved by different cities utilizing similar methods and facing roughly the same problem. The collection of such waste is a public utility, sometimes handled directly by the city, frequently by contractors; and the award of these contracts is not infrequently a matter of political spoils.

More or less temporarily, and upon the basis of a varying measure of competent study, each municipality has had to solve this problem for itself. Solutions are usually temporary because of the rapid growth in the area covered by the cities and because of the development of suburbs. It would seem that the technical, sanitary, and economic aspects of this recurrent problem might well be included among the innumerable projects of the federal government having to do with questions of public health or with technological and economic problems. Various aspects of the subject fall within the province of the Public Health Service as well as within that of the Department of Agriculture. A continued and impartial study of this kind, based upon the results of successful and unsuccessful practice, would without doubt ultimately effect marked improvements in methods of disposition. Such work would provide a body of authoritative

opinion and experience upon which individual cities could draw. It might also tend to lessen the influence of local politics. Certainly continued and specialized work of this kind would develop a more effective solution than the individual effort of single municipalities, facing changing conditions and attempting more or less unfamiliar new methods advocated by private interests.

RENDERING PLANTS

However efficient a given establishment may be, its status is often vitally affected by external influences which require joint action by the industry. A great many such problems face the rendering business. One of these is the matter of dealing with old and frequently obsolete state or local regulations. Changes in the character of the business have made some regulations of this kind unnecessary. Another problem is that of standardization of grades of the products. At the present time the product of each producer is sold on chemical analysis, the buyer also sometimes knowing the source of the product. The nomenclature of grades differs in different sections of the country. All this entails higher costs, impedes marketing, and tends to create local price levels. In different sections of the country the "spread" in prices of tallow and grease is often materially in excess of the cost of transportation.

Furthermore, in the near future the rendering industry will be in increasing competition with municipal collection of wastes, municipal reduction and incineration, as well as with hog feeders. Its relation to such activities needs to be clearly formulated if the business is not to suffer from haphazard local ordinances. Moreover, if methods of processing garbage are materially improved and it becomes profitable—a contingency that seems very likely to eventuate—renderers will attempt to enter this field.

The rendering industry does not seem to have developed even the ordinary type of trade association, though the time seems overripe for such a one. The industry seems admirably suited to the development of co-operative or joint marketing organizations. It consists of many scattered small units and a few large ones. In a given section of the country a group of the small units which do not compete with one another for raw materials, because located in different towns, might form a mutual marketing company through which the output of the members could be sold. Thus the products of a number of small plants could be assembled, uniformly graded and standardized, blended, stored or warehoused, to meet the requirements of the market better than the individual small concern is able to do. The group could sell more effectively. Instead of selling to brokers and to compounders of mixed feed and fertilizer, it could prepare such compounds and market them direct. There would seem to be no legal obstacle to such co-operative marketing, provided the group is not sufficiently large to control national prices and eliminate competition.¹ The plan seems feasible because of the necessarily scattered location of plants. If one such group were successful, similar groups would be organized in other regions.

Similar groupings are already organized or in process of organization in other lines. Groups of wholesale grocers, for example, are being formed, consisting of individual concerns that do not compete with one another because they are located in different cities. This is one of the defensive moves being made by wholesale grocers against the incursions of the chain retail grocery stores. Groups of butchers are also organizing for the disposition

¹ The groups could not well dominate markets because prices reflect world conditions, and because, in the use of fats in industry, substitution is so generally possible and so widely practiced.

of offals. A group of this kind is the Chicago Butchers' Rendering Company, which seems to have been quite successful. Similar organizations are in existence in New York and Milwaukee.¹

At any rate, with the meat-packing and soap industries organized as they are at present, it seems desirable that the rendering industry should become at least trade conscious, and the first step would be the organization of a trade association.

¹ Short-sighted policies of some local renderers in unduly depressing prices of butchers' scrap—one of the most valuable classes of material—seem to have been initially responsible for the development of these organizations.

CHAPTER XIV

SUMMARY

The production of animal by-products bears an important relation to the economics of the food industries. It presents, besides, a number of distinctive economic problems, as well as problems of public health and regulation, that are of serious import to the great livestock industries and to the public. The situation is complex; political factors and more or less obsolete systems of regulation notably affect the working of economic forces. Such non-economic factors limit the industry in some directions and tend to expand it in others, but in many respects they make for economic loss and waste, and foster an artificial development.

RAW MATERIALS

Into the production of inedible fat and joint or related products goes a heterogeneous class of animal material that, owing to origin, character, regulation, or absence of a market, cannot be used for food or edible fat, and also possesses no other industrial use. A study of the raw materials becomes, in effect, an analysis of the sources of incidental by-product and waste: on the farm, in the packing houses, and in the course of distribution and consumption. The volume of such material is immense. It comprises slaughterhouse by-product, condemnations or rejections on account of diseases (entire carcasses or parts of carcasses), animals that arrive at the stockyards or at the slaughtering plants dead or in a dying condition, horses, dogs, and so forth, from the cities and the surrounding territory, dead farm animals, spoiled meats,

trimmings, suet, and bones purchased from meat markets and butchers, kitchen refuse or garbage (defined as the wastes from the preparation and utilization of food) collected from hotels, restaurants, and households, wild horses, fur and leather trimmings, and wastes from poultry-dressing establishments. In short, the by-product industries utilize any class of animal material that is available in sufficient abundance to bear the cost of collection. Broadly, it is material for which there exists virtually no other commercial use.

PRODUCTS

The main product derived from such materials is inedible fat. Chief attention is here given this product, partly because of its relative importance, and chiefly because it affords the best approach to a study of the salvaging industries.

"Inedible animal fats," sometimes termed "waste fats," are predominantly inedible tallow and animal grease, for these constitute about 95 per cent of the domestic production of the group. Animal greases are mainly derived from hog fats and (in rendering plants and municipal reduction works) from kitchen refuse, a nondescript material consisting of meat, fish, and vegetable waste. Inedible tallow is derived mainly from the fat of cattle, calves, and sheep. Within limits, and according to market conditions, raw materials for grease (excepting kitchen refuse) are sometimes mixed with raw materials for tallow, and vice versa. Hogs and cattle are the sources of the great bulk of the inedible fat, for these two classes of stock provide approximately 90 per cent of the domestic supply of meats, with a roughly proportionate amount of by-product and waste.

Tankage and cracklings, the meat and bone residue after the extraction of fat, are high in protein or ammonia

content. These are mainly used as ingredients in mixed feeds and also in fertilizer compounds. The residue from the wet or digester method of rendering is known as tankage; dry rendering and open-kettle rendering yield a product of superior quality known as cracklings. Tankage, whether from edible or inedible materials, is always inedible. Cracklings may be used for food or industrial purposes, according to the character and condition of the raw material. All the cracklings not adapted to human food go to animal feeds. Tankage goes to fertilizer as well as feed, according to its condition. Other products of the salvaging industries are hides, commercial bone, bone meal, bone black or bone char (decolorizing and deodorizing agents used in refining such products as sugar and vegetable oils), dried blood, sausage casings, glue and gelatin, horse oil, and neatsfoot oil. Kitchen refuse and slaughterhouse offal are extensively fed to hogs.

UTILIZATION OF INEDIBLE FATS

Uses of tallow and grease are conditioned by such standards of quality as color, titre, percentage of free fatty acids, moisture, and unsaponifiable matter. The demand of the consuming industries is highly specialized; somewhat different standards apply for different products. The soap-making industry is the principal consumer. It utilizes nearly all of the domestic tallow, chiefly in white toilet and household soaps, and also employs much grease in the manufacture of other, usually low-priced, soaps. Large quantities of grease and relatively little tallow are exported or fractionated for oil and stearin, as well as for red oil, stearic acid, and glycerin. The primary fats as well as the derivatives are severally and differently used for lubricants or admixed with mineral oils for cup greases and other lubricants; they are also employed in cosmetics, candles, for leather dressing,

signal oils and other illuminants, fulling and scouring textiles, foundry work, polishes, and many other purposes.

DOMESTIC DEMAND

All these waste products compete with and supplement other materials, notably vegetable oils, mineral oils, oil cake and other feeds. Particularly in soaps, candles, and lubricants, animal fats have been giving place to vegetable oils, fillers, and mineral oils or their derivatives. Yet total consumption of the animal products has greatly increased; their prices are, as a rule, higher than those of the competitive materials, and imports are growing. These facts indicate a specialized and rising demand, a growing shortage, and, on the whole, a strong position for the by-product industries. The industrial demand for such products is growing much more rapidly than the production of meats; and this, jointly with the improvement in the methods and conditions of rendering, has effected a more intensive utilization of the wastes of distribution and consumption.

The United States exports substantial quantities of animal by-products, and imports a still larger volume. These countercurrents are the result of geographic factors, rail rates and ocean freights, and relative prices and supplies of different grades or qualities. In the group as a whole, net imports are large and increasing. Excluding hides and skins and wool, which are among the largest items in the American import trade, annual imports of animal by-products amount to 30 to 40 million dollars.

In respect of fats and oils, the United States has a heavy surplus of edible animal fats, mainly lard; but it imports about 1½ billion pounds of vegetable oils (including the oil content of imported oil seeds and nuts). The great bulk of these imports is for industrial use,

and a considerable proportion competes with or supplements domestic tallow and grease.

PRODUCING INDUSTRIES

Animal by-products are produced by slaughterers and meat packers and by a group of salvaging industries closely resembling similar departments of the large meat-packing establishments. These salvaging industries comprise rendering plants, municipal reduction works, and plants engaged in the production of glue and gelatin, bone black, and fertilizer. Slaughterers and meat packers largely limit themselves to the processing of by-product that develops within the plant; municipal reduction works collect and render the garbage of households; the other industries purchase slaughterhouse by-products, mainly from the small plants, and also collect heterogeneous materials already described. Only in the rendering and reduction plants is inedible fat the main product; and such plants, with the slaughterers and meat packers, produce around 90 per cent of the total.

Municipal plants as a rule obtain only the garbage of households; a similar but more valuable material from hotels and restaurants is sold by these to renderers (producing "house grease") and to hog feeders. In a considerable number of cities the entire supply of municipally collected garbage is taken by hog feeders, under contract.

TRENDS OF PRODUCTION

Since waste fats are either the major or incidental product of all the salvaging industries, trends in these industries are best shown by reports of fat production. Other data are less adequate.

In 1912 the recorded output of grease and tallow was 358 million pounds, and in 1923 it was 770 million, an increase of over 100 per cent. In the succeeding four years

it fluctuated within narrow limits, the output of 1927 being 773 million, and of 1928, 755 million. Of by-product tankage and cracklings, production in 1928 was about 700,000 short tons. Inclusive of a similar residue from edible fats, the total output of this by-product is over a million tons.

Now the great bulk of the raw material for these commodities arises in the processes of meat production, distribution, and consumption. Yet while the output of by-products has more than doubled, meat production and consumption have shown relatively little change during the period under review. Meat production in 1927 was only about 23 per cent larger than in 1912, according to official estimates, and consumption was about 26 per cent larger. The ratio of inedible fat to meat has grown materially. Breaking down the statistics for a closer view of the situation, we find that slaughterers and meat packers as a rule limit themselves to the processing of wastes that arise within the plant. The proportion of inedible fats supplied by slaughterers declined from 67.9 per cent in 1914 to 45.6 in 1927. In absolute figures there was an increase of nearly 70 million pounds, nearly all of it in grease, tallow fluctuating at or below the level of 1914. The slaughterers' output of waste fat varies roughly with the volume of slaughter, the main variable being the condemnations. The rise in grease seems to be the result of a larger hog slaughter and more numerous condemnations, owing to the prevalence of swine diseases.

There has been a notable expansion in the production of waste fat outside of the meat-packing industry. Tallow and grease from such outside sources constituted 32.1 per cent of the total in 1914 and 54.4 in 1927. The increase was 286 million pounds. Non-packer tallow increased 200 million pounds, nearly sevenfold; grease much less. This trend is just the reverse of that in the meat-packing plants, where grease increased and tallow has on the

whole been declining slightly. The progressive rise in non-packer tallow is noteworthy, inasmuch as cattle slaughter has not greatly varied in recent years.

The great bulk of this non-packer production is the output of the renderers. "House and garbage grease," produced by these and by municipal reduction works, rose from 45 million pounds in 1914 to 93 million in 1927. Reduction works, which produce only grease of this kind, now produce about half of the combined figure. Manifestly, shifts in the output of these establishments do not bulk large in the total expansion, which has been mainly in tallow. Nor is the by-product fat produced by other sources, such as fertilizer and glue works, an important factor in the situation; such fat also consists largely of grease.

Accordingly, the rise in the production of waste fats represents an expansion in the rendering industry. Since the increase has been primarily in tallow, it is apparent that the bulk of the raw material consists of by-products of cattle and sheep. Even after allowing for several qualifying factors, the growth in renderers' tallow seems to reflect a considerable increase in the slaughter outside of federal inspection, a subject upon which there are no trustworthy data. Such unofficial plants have virtually no outlet for edible fats other than a limited local market for lard, and often sell raw fats and by-products to renderers. Nor does the yield of non-packer tallow alone fully reflect such an expansion, for a good deal of the offal of small slaughterers is fed to hogs, some quantities are sold to glue and fertilizer works, and the official data for waste fats do not include the output of retail slaughterers.

A few of the more significant economic and regulatory problems may be summarized in turn. Of the regulatory problems, one of the most important is that of "meat inspection."

PURPOSE OF REGULATION OF THE MEAT INDUSTRIES

"Meat inspection," a term given to an inclusive supervision and regulation of slaughtering and meat-packing establishments, plays an important rôle in the production of animal fats. Primarily such regulation is designed to inhibit the spread of animal disease transmissible to human beings and to livestock, and to insure the wholesomeness of meat foods. Without proper control, a slaughterhouse may disseminate diseases such as tuberculosis, hog cholera, trichinosis, and anthrax, through drainage, flies, rats, and feeding of offals, and in other ways. Contagion may be carried by unsterilized meats, hides, and other products. The term "meat inspection" is misleading, for the condition of commercial meats is not an adequate indication of the state of the animal. Apparently wholesome meats may have come from diseased animals. Effective regulation demands ante-mortem and post-mortem inspection of the live animal, carcass, and entrails; it extends to the sanitation, construction, and operation of the plant, and forbids the employment of workmen suffering from contagious diseases. A secondary purpose of such regulation is to prevent adulteration and to insure proper labeling. The technique of inspection in respect to animals and meats is adequately developed.

FEDERAL AND LOCAL REGULATION

In the United States, the federal government, the states, and the cities are independently and severally responsible for the regulation of different segments of the meat-packing industry. Federal regulation was primarily the result of foreign quarantines, which threatened to destroy the great American trade in meats. Importing countries demanded adequate inspection and certification not only of the exported meats, but also of the entire product of the exporting plants. These, of course, com-

prise the bulk of the interstate plants. Under the interstate commerce clause of the Constitution the federal government assumes jurisdiction over slaughtering and meat-packing plants that engage in interstate commerce—the interstate or “official” establishments; but no plant may receive federal inspection unless it does a fairly regular interstate business of some dimensions. However adequate the non-federal inspection, no unofficial plant may ship meats, fats, or meat foods beyond the confines of a state. Railroads and other public carriers are forbidden to accept meat foods for interstate or export destinations without a prescribed certificate stating that the products have been prepared under federal inspection. A limited exemption is given to small retail butchers and to farmers serving their customers. To the states and cities is left the regulation of plants which do an exclusively intrastate business. Many of the larger cities maintain their own inspection service.

Federal regulation is generally regarded as being thorough and in some respects perhaps severe; except in a few large cities, state or local regulation is admitted to be relatively lax, often virtually non-existent. Where such local regulation exists, furthermore, it usually does not concern itself with adulteration and proper labeling. The federally inspected product is everywhere accepted; the product under state or local inspection is accepted only within the particular state; and even within a state the different local administrations do not always accept meat foods produced under the various kinds of inspection. In a sense, therefore, the markets for meats and edible fats are divided among 48 or more zones. It is a regulatory system that has had serious, though probably unforeseen, economic and sanitary consequences.

Federal inspection entails a larger investment in plant and equipment, higher operating costs, and heavier losses from condemnations. To offset this, plants under such

inspection have exclusive possession of the interstate and export business. While losses from condemnations vary from year to year, they are larger than they were five or ten years ago. At the same time, local outlets for the non-federally inspected product have expanded with the growth in population and the increase in the number and size of cities. Whether these be the causes or whether, as some informed opinion holds, the spread of such diseases as hog cholera has had an important influence, it seems beyond question that wholesale slaughter is showing a tendency to move from federal to local regulation. Economic and regulatory influences alike seem to work in this direction. Upon the trends in retail, custom, and farm slaughter, and in the sale of farm-killed meats, there are no reliable quantitative data.

EFFECT OF REGULATION UPON PRODUCTION OF FATS

Since a substantial part of the material used for inedible tallow and grease arises from condemnations of animals, carcasses, parts, and meats, it is evident that meat inspection is an important factor in the fat situation. Such condemnations tend to be more numerous under federal inspection. Furthermore, federal requirements as to the treatment of certain classes of edible materials result in the "tanking" of such by-products. Where regulation is not effectively enforced, it is fairly certain that a portion of such material goes to food products.

On the other hand, large quantities of by-product meat and food fats from the local plants are forced to non-food use by the divided system of inspection. This is true of most of the edible fats of beef and mutton (including caul and ruffle fats that would yield a high grade of oleo), a proportion of by-product meats or meat specialties for which there is only a limited local food use, and a proportion of the hog fat from which lard would ordinarily be made. Export markets are closed to edible fats that are

not produced in interstate or official plants; so also are the domestic outlets for edible beef and mutton fats. Such fats are used in lard compounds and oleomargarine, producers of which can utilize (with minor exceptions) only the fats from federally inspected establishments. Likewise, some by-product meats and trimmings, which in the latter would go to canned preparations or edible fat, must also be rendered for grease and tallow.

It is true that frequently the local plants do not possess the volume requisite for the most efficient utilization of by-products. Yet such plants, like the smaller official establishments, could dispose of such materials to the larger producers; they could produce edible tallow; and they could unite for the processing of by-products. Such pooling or co-operative processing of by-products does in fact exist, although the products are usually classable as inedible.

Apart from condemnations and apart, also, from the effects of the divided system of inspection, regulation affects the animal by-product industries in other ways. It is one of the factors which limits slaughtering plants to the processing of offals that arise within the plant. With few exceptions, such plants do not collect and render outside wastes. Under certain conditions, such material may be brought into the plant; it must create no nuisance; specific permission must be obtained from Washington for the entry of certain classes of material; it is required that clean, covered containers be used, and so forth. More important, the difference between rendered edible and inedible fats is in part merely one of regulation. Inedible grades are frequently not distinguishable by the senses from edible fats; some of the local product, as already noted, is in fact of edible quality; and in any event, inedible fats could readily be refined and mixed with those of edible grade. An interstate plant must add a denaturant (power distillate) to inedible fats that have

the appearance of food fats. State and city officials rarely enforce a similar requirement; and in practice much of the inedible product of renderers and local slaughterers moves interstate without denaturant.

No criticism is here intended of the federal regulations, the details of which are the reflection of years of administrative experience. The organic law under which such inspection is maintained was obviously drafted without much regard to the economic and sanitary consequences of a divided responsibility for inspection. In any event, it is plain that meat inspection notably affects the entire situation with respect to edible and inedible animal fats.

ECONOMIC LOSSES AND WASTES

The large domestic production of inedible animal fats, which is not approached by that of any other country, is peculiar to the organization of the American meat industries. It is an indication of the magnitude of animal by-product, waste, and preventable economic loss. In the main, these are inter-industry losses, beyond the control of individual producers. Obviously, the ultimate burden falls upon the public, although in some instances the livestock producers and meat packers are the more immediately affected. Of such a character are the heavy losses from disease on farms and in the meat-packing plants. Together, these alone represent a potential product amounting to well over 10 per cent of the annual output of meats. Such, also, are the economic losses arising from death, crippling, and injury in the transportation of livestock. There is, it is true, a well-defined program for the control of animal disease; efforts are also being made to reduce avoidable damage arising from transportation. Other and less obvious economic wastes are not so readily attacked: the economic losses arising from present methods of marketing meats; the economic losses in the unofficial or local

slaughtering plants, in so far as the present divided system of regulation impedes the more profitable use of surplus and by-product; the unrestricted development of small local establishments; the wastes in distribution and consumption, and the conditions attending the disposal of municipal refuse. Of the 30 odd billion pounds of kitchen waste, largely available for feed, fertilizer, and animal fat, the major portion is incinerated, dumped, or buried, and the disposition of it is a substantial item of municipal expense.

GROWTH OF SALVAGING INDUSTRIES

The total amount of animal by-product and waste is huge; although probably only a minor portion is salvaged, the output of derived products is large and apparently increasing. The development of the salvaging industries reflects in a striking way certain concurrent changes in related industries and in the economic life of the country. For commercial salvage a mass of material must be locally available; it is usually not feasible to transport animal matter of this kind by common carrier. The growth in the urban population has made reclamation profitable by concentrating great volumes of wastes within a relatively small area. Betterment of roads and the motor truck have reduced costs of collection and enabled scavengers to accumulate supplies from a wider territory. The volume of material has been further enhanced by changes in urban food habits making for waste of fat, and by the increasing patronage of hotels and restaurants. Along with the greater availability of animal by-products, the methods of production have been improved. Equally important, the domestic and foreign demand for the derived products has increased more rapidly than has the demand for meats. Almost every article of modern commerce requires in its production or use the application of some by-product of the animal industries. Slaughter-

house offals, formerly the chief source of inedible fat, tankage, and the like, no longer provide an adequate volume of raw material. It is noteworthy that prices of the derived products have on the whole been rising in recent years, despite the large increment in production and heavy imports.

THE RENDERING INDUSTRY

On the growth of the rendering industry the development of dry rendering and other improvements in methods of production have exerted a material influence. These have largely eliminated the objectionable features of such establishments. However, the business still suffers from local restrictions of various kinds; and many municipalities do not permit such plants within city limits. Costs have been reduced, and a larger and better product is now obtained from a given quantum of material. The effect of improving technique is seen in the larger output per unit of labor and per plant. Although establishments of considerable size are to be found in the large cities, the industry is characteristically one of small units. The commonest type employs several workmen and has an output of well under \$100,000. It is essentially a local industry, plants being limited to the raw materials locally available. There are approximately 900 rendering plants in the United States.

Most of the rendering plants are found in the Northern and Pacific states. In many cities and urban districts, notably in the South, such plants are few or non-existent. A further expansion in the output of such salvaging industries seems probable, although such expansion is likely to be slow and to result chiefly from the erection of plants in areas not now served. Much depends upon regulation, upon the attitude of the municipal reduction plants, and upon developments in the slaughtering industry, which thus far has not attempted to engage exten-

sively in such work. In some localities renderers are prohibited by ordinance from collecting the more valuable wastes of hotels, and so forth, the loss of which makes municipal disposal more costly.

MUNICIPAL REDUCTION

Probably no other class of municipal refuse has been so troublesome, in respect to disposal, as kitchen waste or garbage. The average per capita "production" of such material seems to be over 250 pounds. It is one of the largest items of municipal refuse; it must be collected at frequent intervals because it decomposes rapidly, and costs of collection and disposal are high. Different methods of disposal are employed, such as reduction, incinerating, dumping, burying, and feeding to hogs. Garbage contains plant and animal food and grease, the efficient recovery of which offers an opportunity for reducing costs of collection and disposal. With the present methods, reduction does not appear to be practicable in cities with a population of less than 100,000.

There exists considerable difference of opinion regarding the practicability of reduction. Widely varying results are reported in different cities. Seven of the present plants are now owned by private interests operating under long-term contracts with the municipalities. The city collects and delivers garbage to such private contractors, pays them a subsidy, and also permits them to retain the recovered products. Some municipally operated plants show a substantial profit over costs of operation, while others report a large net operating loss, exceeding costs of incineration. These variations appear to result from differences in efficiency of plants and management and from city politics.

One of the factors limiting the success of such establishments is the competition of renderers and feeders,

who collect the larger and "richer" accumulations of hotels, restaurants, and institutions. To the city is left the collection of inferior wastes from innumerable households.

FEEDING OFFAL AND GARBAGE TO HOGS

The feeding of garbage to hogs is known to be extensive and to prevail pretty generally throughout the more thickly settled districts. No statistics are available for the measurement of the extent of this practice. Usually feeders collect only the accumulations of the large establishments, but a number of cities deliver municipally collected refuse to stock farms under contract. Garbage is virtually a complete hog feed, but tends to produce soft pork and lard. From the general facts with respect to the supply and price of feeds and prices of meats, the tendency seems to be toward an increase in such feeding. In the smaller cities and towns it is the most economical method of disposing of garbage. This practice presents, however, a variety of problems, notably with respect to the mode of collection and of contracting for collection and disposal, as well as the best methods of feeding and sanitation.

PROBLEMS OF PUBLIC AND BUSINESS POLICY

The salvaging industries are still in their infancy. Along with a fuller utilization of existing raw materials, the present technique of production and marketing will doubtless be further improved and new products or uses developed. It is in the development of outlets for such by-products, in fact, that the slaughtering industry has been making its greatest advances in recent years. Yet the evolution of the salvaging industries throws into sharp relief certain problems of public and business policy, of sanitation and regulation, that are of serious import. The

situation is complex; it involves legal, technical, economic, and sanitary or medical considerations. It seems possible, however, to indicate certain procedures that are palpably desirable.

Reconsideration of the present system of meat inspection—the regulation of slaughtering and meat-packing plants—is an outstanding need. Based upon the Meat Inspection Act of 1906, the present system may have been reasonably adequate at the beginning of the century. It is, however, increasingly inadequate in the radically different conditions of 1929. Of the sanitary and economic consequences of the divided system of regulation, enough has already been said to indicate the need of a single responsibility for such regulation, in lieu of the large number of distinct administrations existing today. Such regulation is essentially an interstate or federal function, since laxness of local regulation may render abortive, in part at least, the efforts of the federal government and states for the control of animal disease.

It is possible that the federal government may legally take jurisdiction under the taxation clause as in the case of oleomargarine. The average cost for federal inspection, about 7 cents per head, is defrayed from the appropriation for federal meat inspection. States and municipalities assess a much higher direct tax upon packers for local inspection. Doubtless a single administration would be more economical. Moreover, by reducing a varied class of economic losses, it would benefit both the meat packers as a class and the livestock producers.

Apart from the problems arising from the divided responsibility for meat inspection, certain regulations of the federal meat inspection service, and certain provisions of the Meat Inspection Act of 1906 itself, apparently need adaptation to the changed technical and economic conditions of the meat-packing and related industries.

Some restriction of the operations of small butchers

and slaughterers appears also to be needed. Particularly in the smaller cities and municipalities such producers might be required to conduct their slaughtering in a common, restricted area. An extension of co-operative or municipal abattoirs, a few of which are in existence, seems to be indicated. This would facilitate inspection and effect economies in the utilization of by-product.

The statistics of slaughter, production, and consumption of meats and animal by-products serve many important uses. Industry in general now recognizes the practical value of such information in guiding business policy. Such facts also serve administrative or regulatory purposes, apart from their utility in dietary and economic investigations. The data biennially issued by the Census Bureau are in many respects inadequate; and excepting those relating to federal inspection, the annual statistics of the Department of Agriculture are crude approximations. For an informed view of the status of federal and other inspection, production, and consumption, the first requisite is a census of retail and custom slaughter, of sales of farm-killed meats, and of farm slaughter. In default of this, the federal Department of Agriculture, through its meat inspectors and other field agents, appears to possess the requisite facilities for making valuable sample studies. Here permissive legislation and supplemental appropriations may be required.

To attack problems relating to uniform grades and standards, as well as more or less obsolete regulation, the rendering industry seems to require some form of trade association. Apparently this widely dispersed industry, consisting of a large number of small units, has as yet not become sufficiently trade-conscious for the development of such an organization. These numerous small units do not possess facilities for the effective handling of their products; they usually sell to compounders of mixed feed and fertilizer, and to brokers. Co-operative

pooling or assembling units for the purpose of grading, standardizing, and blending may serve a desirable function. In view of the extent of the mergers in the industries purchasing the products of the renderers and of the resulting concentration of buying, such a move appears to be indicated.

Among the more troublesome and costly functions of American municipalities are those relating to the collection and disposal of municipal refuse. Few cities have developed a satisfactory solution; and the growth in cities and suburbs calls for periodical revision of existing methods. Although the problems appear to fall within fairly well-defined classes, according to size of cities and local conditions, widely different methods are employed, with wide variations in cost and effectiveness. The general subject might well be added to the innumerable research functions of the federal government having to do with public health and welfare. It would provide a body of expert and impartial opinion upon which municipalities might draw. The development of an economical system of reduction would benefit agriculture by adding large quantities of fertilizer and feed, apart from meeting the growing shortage of industrial fats.

The competition for animal by-products and meat wastes, by rendering plants, municipal reduction works, and hog feeders, lessens the opportunity for an economical and effective disposal of such materials. For commercial salvage a large volume of material must be locally available. A more conscious or directed development of the salvaging industries appears to be needed. It seems to be a case where unrestricted competition serves neither public nor private interest.

APPENDIX

A. COMMERCIAL GRADES OF INEDIBLE TALLOW, GREASE, AND DERIVATIVES, AND METHODS OF SALE

For tallow and grease there are no definite, generally accepted standards. The bases on which these products are bought and sold by the largest producers and brokers are here given. These standards apply primarily to the business in Chicago and other important packing centers. Data for tallows and greases were made available through the courtesy of the Institute of American Meat Packers in the form of a memorandum submitted by one of the largest fat-and-oil brokers in Chicago. This has been supplemented by some data from *By-Products of the Packing Industry*, by R. A. Clemen (Chicago, 1927), and by some material obtained by correspondence. Data for stearic acid and red oil are from correspondence with manufacturers.

M.I.U..—Tallows and greases are sold upon the basis of a stated maximum content (1 to 3 per cent) of M.I.U.—moisture, impurities, and unsaponifiable matter. Illustration: A shipment of 60,000 pounds of tallow, bought at 10 cents per pound, 1 per cent M.I.U., is found to contain only 98 per cent of saponifiable fat; i.e., 2 per cent M.I.U. In this case a deduction is made from the purchase price for the 1 per cent excess of the allowance. In the stated case the deduction is 600 pounds at 10 cents, or \$60.00.

Acid and Titre.—Adjustments for an excess of free fatty acid, or a titre that is too low (see specifications below), are determined upon the basis of the value of glycerin, stearic acid, and red oil. If stearic acid is high, and "hard" fats are in demand, the adjustment is greater. If glycerin is high, the fat that yields the least glycerin would be lowest in value. The yield of glycerin varies inversely with the percentage of free fatty acids. Ordinarily the precise terms are stated in the contract of sale.

INEDIBLE TALLOW¹

As a class these are always hard in body, 40 degrees titre or higher, and are primarily beef fat, though grease is occasionally mixed with tallow when prices of the latter are higher. Some classes of inedible tallow are comparable, in whiteness of color

¹ See also pp. 49-58.

and lowness of free fatty-acid content, to edible tallow, but are not permitted by federal regulation to go into food uses.

1. *Fancy* is usually sold "maximum 3 per cent acid," 42 to 44 degrees titre, 1 per cent M.I.U.

2. *Prime Packers'* is a standard tallow. The bulk of the packers' product is of this grade. It is sold in the winter "maximum 3 per cent acid," in the summer "maximum 4 per cent acid," runs 42 to 43½ degrees titre, and is sold basis 1 per cent M.I.U. It is light in color, bleaches not to exceed 2.8 red and 25.0 yellow by the Lovibond color test. It is made from the best grade of packers' inedible stock.

3. *Number One* usually runs 8 to 14 or 15 per cent acid, but is sold by most packers on a basis of 10 per cent acid. It may be either a greenish or brownish tallow, or sometimes "yellowish." It is rendered from the less desirable parts of the animal, containing some spoiled fats and being "off" in odor and flavor. It bleaches to about 7.0 red and 31.0 yellow (Lovibond test). This grade is given various names by different producers, but is classed by the trade as "No. One" if it conforms to these specifications. It is sold on a basis of 2 per cent M.I.U.

4. *Number Two* is sold on the basis of 2 per cent M.I.U., and usually contains 25 to 30 per cent acid, but the true "Number Two" is sold on the basis of 40/40 (40 per cent free fatty acids and 40 degrees titre). It is too dark in color to be read by the Lovibond test. This tallow is made from the remaining dark-colored stock and poorest grade offals, such as gut fats, as well as catch-basin skimmings. Frequently catch basins are skimmed and rerendered and this put into Number Two. Some tallow of this grade runs up to 43 degrees titre. This grade is sometimes classed as "B" tallow. It is also sometimes described as brown grease.

5. *City Tallow* is a renderers' product. It is produced from materials that are gathered daily and promptly rendered. It is a product of fairly good and uniform quality.

6. *Country Tallow* is a lower grade of renderers' product than the grade known as "City Tallow." Made from fats and materials collected at intervals and accumulated, it varies greatly in free fatty-acid content and color.

GREASES¹

Primarily hog fats, 37 to 39½ degrees titre, free fatty acids (see below) may run from 1 to 60 per cent. The lower packer

¹ See also pp. 49-58.

grades, yellow and brown, are sometimes designated as "soap stock." When greases are grained and pressed they yield grease oils or lard oils. The latter are usually bleached.

1. *Choice White* is an inedible grease, similar to lard in color, generally 38-39 degrees titre, runs "maximum 4 per cent acid," 1 per cent M.I.U.

2. A *White* is 6 to 7 per cent acid, slightly darker in color than "choice white," 1 per cent M.I.U.

3. *B White* is 8 to 12 per cent acid, sold 1 per cent M.I.U. It is poorer in color, dark or yellowish, "off" in odor and flavor; color is lighter than 2.5 red and 25.0 yellow (Lovibond).

4. *Yellow* runs 15 to 25 per cent acid, sold on a basis of 2 per cent M.I.U. It is yellowish in color, but never brown; made from portions of the animal that yield a darker grease, and is really an offal product. In some small plants all grease materials are rendered together, and the resulting product is known as yellow grease; color is about 30 red and 110 yellow (Lovibond).

5. *Brown* is sold on a basis of 40/40 (40 per cent free fatty acids and a titre of 40 degrees), and 2 per cent M.I.U.; made from all refuse materials, such as catch-basin skimmings, floor sweepings, and so forth.

6. *House* is obtained from the rendering and degreasing of used fats or shortenings from hotels, and similar wastes. A renderers' product, this house grease does not bleach well, but is usually low in acid because it is handled or rendered quickly; sold 3 per cent M.I.U.

7. *Garbage* is grease extracted from garbage, usually by municipal reduction plants; sold 3 per cent M.I.U.

8. *Extraction* is grease extracted from partially degreased tankage, in turn sold for fertilizer. It is very dark in color, 12 to 15 per cent acid; sold 3 per cent M.I.U. The number of such degreasing plants is reported to be increasing.

DERIVATIVES

1. *Lard Oil and Grease Stearin*.—A large portion of the grease goes to "lard oil pressers," who grain and press out the softer portions, "lard oil" or grease oil, and obtain a hard-bodied grease, "stearin." The yield is approximately 55 per cent oil and 45 per cent stearin. White greases yield lard oil; yellow grease, and lower grades, yield grease oil.

Choice White grease is rarely pressed, being mainly exported. If pressed, it yields "extra winter strained lard oil" and "choice white grease stearin."

"A White" grease yields "extra lard oil" or "extra winter strained lard oil" (according to the temperature at which it is pressed) and "A white grease stearin."

"B White" grease yields "extra No. 1 lard oil" and "B white grease stearin."

(The better grades of lard oil are sometimes sold as "neatsfoot oil.")

"Yellow" grease yields "No. 1 grease oil" and "yellow grease stearin."

"Brown" grease yields "No. 2 grease oil" and "yellow grease stearin."

2. *Stearic Acid, Red Oil, and Glycerin.*—Large quantities of grease are also processed by stearic acid manufacturers for stearic acid, red oil, and glycerin. Yields of the three products vary with the quality of raw material and the processes employed. One large manufacturer reports a yield, from 100 pounds of fats, of 60 pounds of red oil or oleic acid, 30 pounds of stearic acid, and 8 pounds of glycerin. Another reports 45 per cent each of stearic acid and red oil and 5 per cent of glycerin. The balance is tar, and so forth.

The "distilled" grades of stearic acid are produced from low-grade greases such as brown, extracted, and garbage grease; and the "saponified" from better grades. The main reason for the distillation process is to permit the use of low-grade materials, which are distilled to bring back the original white or yellow color. Oleostearin is occasionally processed in this manner when a high-grade product is desired. These refinements are of importance to manufacturers of candles, cosmetics, and crayons. For certain purposes, notably for rubber compounding, stearic acid is also purified by various degrees of pressure and sold as single-, double-, and triple-pressed. The primary purpose of such pressing is to reduce the content of oleic acid (15 per cent in single-pressed, 10 in double-pressed, and 5 in triple-pressed), because an excess of such acid is detrimental in the aging of certain types of rubber compounds.

B. STATE REGULATIONS WITH RESPECT TO SALE OF COMMERCIAL FEEDSTUFFS¹

Specific statutes closely regulate the sale of commercial feeding stuffs in the states where such feeds are extensively used.

¹ *Report of the Federal Trade Commission on Commercial Feeds* (March 29, 1921), pp. 174-77, 185.

These apply to feeds of animal origin as well as to other commercial feeds. In their essential provisions the different state laws are virtually uniform.

1. They require the registry, by name, brand, or trade-mark, of the different products offered or exposed for sale.

2. Such registration must show the guaranteed chemical composition of the commodity in percentages of protein, fat, and fiber, and the common names of the ingredients.

3. The container, or the tag accompanying each package, must show plainly the net weight, name, brand, or trade-mark of the commodity, and also the name and address of the manufacturer or person responsible for placing it on the market.

4. Such container or tag must show the minimum percentage of crude protein and crude fat, and the maximum percentage of crude fiber, and also the name of each ingredient used in its manufacture.

5. A system of analysis and sampling is usually prescribed to insure compliance with the foregoing provisions, and publicity is usually given to the results.

6. Penalty provisions are added for violation of the statutes.

Through the Association of Feed Control Officials of the United States it has been possible to attain a large measure of co-operative and uniform regulation. Federal and state officials meet annually for discussion of problems and recommendations of procedure. This has tended toward uniformity in regulating intrastate and interstate commerce, as well as in administrative and regulatory methods.

C. DEFINITIONS OF ANIMAL FEEDSTUFFS OF ANIMAL ORIGIN, ADOPTED BY THE ASSOCIATION OF FEED CONTROL OFFICIALS OF THE UNITED STATES¹

Cracklings are the residue after partially extracting the fats and oils from the animal tissues. If they bear a name descriptive of their kind, composition, or origin, they must correspond thereto.

Digester tankage is the residue from animal tissues, exclusive of hoof and horn, specially prepared for feeding purposes by tanking under live steam, drying under high heat, and suitable grinding. If it contains more than 10 per cent of phosphoric acid (P_2O_5), it must be designated digester meat and bone tankage.

¹ *Report of the Federal Trade Commission on Commercial Feeds* (March 29, 1921), pp. 185-86.

Meat scrap and meat meal are the ground residues from animal tissues, exclusive of hoof and horn. If they contain more than 10 per cent of phosphoric acid (P_2O_5), they must be designated meat and bone scrap and meat and bone meal. If they bear a name descriptive of their kind, composition, or origin, they must correspond thereto.

Blood meal is ground dried blood.

D. METHODS OF QUOTING PRICES UPON TANKAGE AND CRACKLINGS¹

Meat residues are valuable for their content of protein, fat, and mineral salts. Formerly products such as tankage were sold at a flat rate per ton. They are now marketed on a guaranteed chemical analysis. It is the present practice to base quotations upon "units of ammonia," with an allowance for the bone-phosphate content. Under this custom the value of the product depends primarily upon the content of nitrogen. It is usual to express this as protein in feeding stuffs and as ammonia in fertilizers. The direct determination is made by the chemist upon the amount of nitrogen present. Nitrogen is multiplied by 1.215 for ammonia, and by 6.25 for protein. Thus 10 per cent of nitrogen is equivalent to 12.15 per cent of ammonia, or 62.5 per cent of protein. The trade, however, uses the term ammonia to designate the content of the material, whether sold for feed or fertilizer. A "unit" of ammonia is 1 per cent per ton, or 20 pounds. In producing feed tankage the addition of hair, hoof meal, and the like is usually forbidden because these possess little feeding value, although they are high in ammonia content.

In addition to ammonia, a flat price of 10 cents per unit of bone phosphate is added. Thus a quotation upon tankage or cracklings of \$4.50 and 10 cents" would mean that the ammonia is sold at \$4.50 for each per cent per ton (or unit of 20 pounds) and the bone phosphate at 10 cents for each similar unit. A tankage analyzing 9 per cent ammonia and 20 per cent bone phosphate would sell for 9 times \$4.50 plus 20 times 10 cents, or \$42.50 per ton. Garbage tankage, however, is usually sold at a flat rate per ton.

Packers usually sell a tankage with a protein content of 60 per cent and 6 to 8 per cent of fat. Since the ordinary packing-house tankage will average only about 33½ to 41½ per cent of protein,

¹ *The Packers' Encyclopedia* (Chicago, 1922), pp. 138-39; R. A. Clemen, *By-Products in the Packing Industry* (Chicago, 1927), pp. 317-26.

various materials such as blood and dried stick are added to bring up the content. Blood will analyze 15 or 16 per cent of ammonia. Tankage from condemned carcasses, or materials containing considerable quantities of bone, also steamed bone tankage, are generally used for fertilizer purposes.

E. DISTRIBUTION AND OCCURRENCE OF FATS IN THE ANIMAL CARCASS¹

On the basis of anatomical and physiological considerations, the fats of the animal body may be divided into three classes, which overlap somewhat but nevertheless display important distinguishing characteristics. The first class may be termed metabolic fats. These are contained in the cells of the various tissues and in other intimate relations to the structures of the body and possess important functional attributes. The metabolic fats are not greatly expanded when the gross fat of the body is increased and the tissues cling to them tenaciously during emaciation. The second class may be termed supporting fats, since they aid in maintaining the position and mobility of certain structures, especially the viscera. These fats are found around the kidneys, in the omentum, and in general are disposed around the organs in the visceral cavities. Also, some of the fats in the trunk and extremities, associated with connective tissues, belong to the supporting fats. These fats are subject to increase in obesity and waste away during emaciation. The third class of fats may be termed reserve fats, representing the storage depots of the body, one disposed over the extremities, in the ventral and dorsal walls of the trunk, and generally through the subcutaneous connective tissues. It is the reserve fats which are most prominently increased in obesity in human beings, and in the fattening of animals for market, and most extensively withdrawn in consequence of emaciation.

These fats display important differences in composition. The metabolic fats vary in composition from species to species and within one body from organ to organ; thus, the fats of the nerve, of the heart muscle, and of the kidney are significantly different. The so-called supporting fats display a less specific composition than the metabolic fats, but are consistently of a firmer texture than these. The composition of the reserve fats depends to a considerable extent upon the diet of the animal: when formed from carbohydrate, they tend to be specific to the species, but

¹ Contributed by Dr. A. E. Taylor.

when formed from the fat of the diet, they tend to resemble the ingested fat. Other things being equal, the reserve fats tend to have a lower melting-point and titre than the supporting fats. This is an important fact, which explains the quality and corresponding price premium of the fat of the caul and around the kidney.

TABLE I.—MONTHLY PRICES OF TALLOW AT CHICAGO, 1920-28*
(Cents per pound)

Month	Edible	Prime Packers'	No. 1 Packers'	No. 2 Packers'	No. 1 Renderers'	No. 2 Country
1920						
Jan.	18.8	17.6	16.8	13.8	16.4	14.0
Feb.	17.1	16.0	14.9	13.0	15.2	13.4
Mar.	17.0	16.1	15.0	13.1	14.5	12.6
Apr.	16.2	15.6	14.5	13.1	14.2	12.6
May	15.0	13.9	13.1	11.4	13.2	11.8
June	13.0	12.0	10.5	9.2	10.6	9.5
July	13.2	12.4	11.2	9.6	10.5	8.6
Aug.	13.1	12.8	11.2	9.0	10.2	8.0
Sept.	14.4	13.8	11.8	9.2	10.0	8.5
Oct.	12.5	11.2	9.5	6.6	8.2	6.8
Nov.	9.6	8.2	6.9	5.0	6.6	4.8
Dec.	7.1	6.5	5.6	4.0	5.5	3.9
<i>Average</i>	13.9	13.0	11.8	9.8	11.3	9.5
1921						
Jan.	7.4	6.8	5.8	4.6	5.6	4.5
Feb.	7.0	6.2	5.2	3.9	5.0	3.6
Mar.	6.4	5.9	4.9	3.6	4.5	3.4
Apr.	6.2	5.8	4.9	3.2	4.4	2.9
May	6.6	6.1	5.0	3.2	4.5	3.1
June	6.0	5.5	4.4	3.0	4.0	2.6
July	6.4	5.6	4.5	3.0	4.1	2.6
Aug.	7.2	6.6	5.2	3.4	4.8	3.1
Sept.	8.2	7.2	6.1	3.9	5.6	3.6
Oct.	7.8	7.2	6.2	4.0	5.9	4.0
Nov.	7.2	6.8	5.9	4.0	5.5	3.5
Dec.	7.0	6.6	5.8	4.1	5.1	3.8
<i>Average</i>	7.0	6.4	5.3	3.6	4.9	3.4
1922						
Jan.	7.4	6.6	5.8	4.2	5.2	4.1
Feb.	8.0	6.9	5.9	4.6	5.9	4.9
Mar.	8.0	7.0	6.4	4.8	5.9	4.9
Apr.	7.2	6.9	6.2	5.0	6.0	4.9
May	7.2	6.6	6.1	5.1	5.9	4.9
June	7.6	6.5	6.0	4.9	5.6	4.9
July	7.9	6.6	6.1	4.9	5.8	4.9
Aug.	8.1	6.9	6.2	5.0	6.0	5.1
Sept.	7.6	6.9	6.2	5.2	5.9	5.2
Oct.	8.1	7.5	7.1	5.8	6.6	5.9
Nov.	8.5	8.2	7.6	6.2	7.8	6.6
Dec.	8.8	8.4	7.8	6.9	7.5	7.0
<i>Average</i>	7.9	7.1	6.4	5.2	6.2	5.3

* Data for the first four columns (for the years 1920-27) computed as means of monthly ranges from a statistical pamphlet issued January 1, 1928, by the Davidson Commission Co., Chicago. For the present purpose these means are serviceable, because the monthly range is usually within three-fourths of a cent per pound.

All other data were compiled from weekly quotations of the *Oil, Paint, and Drug Reporter*. To make the data comparable, the same method was employed.

INEDIBLE ANIMAL FATS

TABLE I (Continued)

Month	Edible	Prime Packers'	No. 1 Packers'	No. 2 Packers'	No. 1 Renderers'	No. 2 Country
1923						
Jan.	9.5	9.0	8.5	7.9	8.2	7.6
Feb.	9.3	8.7	8.6	8.1	8.4	8.0
Mar.	9.8	9.5	9.1	8.6	8.8	8.6
Apr.	10.0	8.9	8.7	7.9	8.6	7.9
May	8.8	8.1	7.4	6.6	7.5	6.9
June	8.2	7.2	6.8	5.8	6.4	5.5
July	7.6	6.9	6.2	5.2	5.9	5.1
Aug.	8.1	7.5	6.9	5.6	6.2	5.2
Sept.	9.2	8.1	7.5	6.1	6.9	6.0
Oct.	9.5	8.5	7.6	6.0	6.8	5.8
Nov.	9.6	8.5	7.6	6.0	7.0	5.8
Dec.	9.2	8.1	7.4	5.9	6.9	5.6
Average	9.1	8.2	7.7	6.6	7.3	6.5
1924						
Jan.	9.4	8.4	7.6	6.2	7.2	5.8
Feb.	9.0	8.1	7.5	6.2	7.2	5.9
Mar.	8.6	8.0	7.5	6.2	7.0	6.0
Apr.	8.2	7.6	7.1	6.2	6.6	5.9
May	8.4	7.3	6.9	6.0	6.6	5.9
June	8.5	7.1	6.6	5.9	6.5	5.5
July	10.0	7.9	7.4	6.2	7.1	6.1
Aug.	11.5	8.9	8.1	6.9	7.8	6.6
Sept.	10.1	8.9	8.1	6.9	7.9	6.6
Oct.	9.6	9.2	8.6	7.2	8.4	6.9
Nov.	10.1	9.6	9.2	7.5	8.9	7.4
Dec.	10.6	10.3	9.8	8.5	9.2	8.4
Average	9.5	8.4	7.9	6.7	7.5	6.4
1925						
Jan.	10.5	9.9	9.8	8.9	9.1	8.6
Feb.	9.5	9.4	8.7	8.4	8.8	7.7
Mar.	10.2	9.8	9.3	8.8	9.1	8.4
Apr.	10.1	9.4	9.1	8.2	8.7	7.9
May	9.5	9.2	8.7	7.9	8.5	7.6
June	9.9	9.4	8.9	8.2	8.6	8.0
July	11.1	9.8	9.4	8.8	9.4	8.5
Aug.	10.4	10.0	9.5	8.8	9.2	8.4
Sept.	10.8	10.1	9.5	8.4	9.1	8.1
Oct.	10.6	10.0	9.5	8.2	9.1	7.9
Nov.	10.4	10.0	9.4	8.2	9.1	7.9
Dec.	10.4	9.9	9.4	8.3	9.2	8.1
Average	10.3	9.7	9.3	8.4	9.0	8.1

TABLE I (Concluded)

Month	Edible	Prime Packers'	No. 1 Packers'	No. 2 Packers'	No. 1 Renderers'	No. 2 Country
1926						
Jan.	10.5	10.2	9.4	8.4	9.3	8.1
Feb.	10.2	9.8	9.2	8.2	9.0	8.1
Mar.	10.0	9.4	9.0	8.0	9.0	7.9
Apr.	9.5	8.6	8.1	7.4	8.1	7.2
May	9.6	8.8	8.3	7.4	7.9	7.3
June	10.9	9.1	8.5	7.5	8.2	7.4
July	10.2	8.4	8.0	7.1	7.9	7.1
Aug.	9.5	8.5	7.8	6.9	7.6	6.8
Sept.	9.4	8.5	8.0	7.0	7.8	6.8
Oct.	8.6	8.4	7.5	6.5	7.4	6.2
Nov.	7.8	7.4	6.8	5.7	6.6	5.7
Dec.	7.6	7.2	6.7	5.7	6.6	5.4
<i>Average</i>	8.5	8.7	8.1	7.2	8.0	7.6
1927						
Jan.	7.9	7.5	6.9	5.5	6.7	5.5
Feb.	8.5	7.9	7.4	6.1	7.1	5.9
Mar.	8.6	7.9	7.3	5.9	7.2	5.9
Apr.	8.0	7.6	7.1	5.8	7.0	5.6
May	8.1	7.8	7.2	6.0	7.1	6.0
June	8.1	7.8	7.2	6.2	7.1	5.9
July	8.2	7.9	7.4	6.1	6.8	6.0
Aug.	8.8	8.2	7.5	6.4	7.0	6.1
Sept.	9.8	8.5	7.9	6.6	7.4	6.4
Oct.	10.1	8.9	8.1	6.8	8.0	6.8
Nov.	10.2	9.1	8.3	6.9	8.0	6.8
Dec.	9.4	8.5	8.1	6.9	7.8	6.5
<i>Average</i>	8.8	8.1	7.5	6.3	7.3	6.1
1928						
Jan.	9.5	9.0	8.2	7.0	8.2	6.5
Feb.	9.0	8.4	7.9	7.1	7.8	6.4
Mar.	9.2	8.8	8.1	6.8	7.8	6.5
Apr.	9.6	8.7	8.2	7.0	7.9	6.5
May	9.4	8.7	8.2	7.2	8.1	6.8
June	9.0	8.3	7.9	7.0	7.9	6.8
July	8.9	8.4	7.9	7.1	7.8	6.6
Aug.	9.0	8.4	8.0	7.1	7.9	6.8
Sept.	9.6	9.0	8.5	7.4	8.3	7.1
Oct.	9.9	9.3	8.7	7.9	8.6	7.3
Nov.	9.8	9.4	8.9	7.9	9.0	7.4
Dec.	9.7	9.3	8.9	8.1	8.6	7.5
<i>Average</i>	9.4	8.8	8.3	7.3	8.2	6.8

INEDIBLE ANIMAL FATS

TABLE II.—MONTHLY PRICES OF GREASES AT CHICAGO, 1920-28*
(Cents per pound)

Month	Choice A White	Yellow	Brown	House	Garbage	Bone Naphtha
1920						
Jan.	17.0	15.0	14.0	14.2	10.8	12.2
Feb.	14.6	13.5	12.6	14.2	10.9	11.8
Mar.	15.5	14.0	13.0	13.5	10.9	11.5
Apr.	14.4	13.5	13.1	13.2	10.6	11.5
May	13.4	12.0	11.2	12.4	10.6	11.2
June	11.4	9.9	9.4	9.8	8.4	9.4
July	11.5	10.1	9.6	9.1	8.1	9.0
Aug.	11.8	9.5	8.6	8.8	7.1	7.2
Sept.	13.0	9.9	8.5	9.0	6.9	7.1
Oct.	12.6	7.8	6.2	7.5	5.5	5.9
Nov.	10.1	6.0	4.8	5.0	4.5	4.6
Dec.	7.1	4.8	4.0	3.9	3.5	3.8
<i>Average</i>	12.7	10.5	9.6	10.0	8.2	8.8
1921						
Jan.	6.1	5.0	4.4	4.6	3.5	4.2
Feb.	5.6	4.2	3.5	4.0	3.0	3.5
Mar.	5.5	4.0	3.4	3.5	3.0	3.1
Apr.	5.4	4.0	3.1	3.0	2.5	2.8
May	5.5	4.0	3.2	3.1	2.4	3.0
June	5.1	3.6	2.8	2.9	2.2	2.8
July	5.4	3.6	2.8	2.9	2.2	2.5
Aug.	6.0	4.4	3.1	3.6	2.4	2.6
Sept.	6.6	4.4	3.9	3.9	2.6	3.0
Oct.	6.6	4.5	4.0	4.2	3.2	3.2
Nov.	6.5	4.5	4.0	4.2	3.4	3.4
Dec.	6.2	4.6	4.1	4.2	3.5	3.5
<i>Average</i>	5.9	4.2	3.5	3.7	2.8	3.1
1922						
Jan.	6.5	4.8	4.2	4.6	3.6	3.8
Feb.	7.0	5.2	4.5	5.1	3.9	4.0
Mar.	7.4	5.5	5.0	5.0	4.2	4.4
Apr.	7.0	5.5	5.0	5.0	4.1	4.5
May	7.1	5.5	5.0	5.1	4.2	4.4
June	7.1	5.5	5.0	5.1	4.2	4.6
July	7.0	5.6	5.1	5.1	4.2	4.9
Aug.	7.1	5.8	5.3	4.9	4.4	5.0
Sept.	7.1	5.9	5.4	5.2	4.1	4.9
Oct.	7.6	6.6	6.0	6.4	5.1	5.5
Nov.	8.4	7.6	6.5	7.2	5.9	6.4
Dec.	8.5	7.6	7.2	7.2	6.0	6.5
<i>Average</i>	7.3	5.9	5.4	5.5	4.5	4.9

* For sources and method of computation, see footnote to Table I. Dots (....) indicate no quotations.

TABLE II (Continued)

Month	Choice A White	Yellow	Brown	House	Garbage	Bone Naphtha
1923						
Jan.	8.9	8.4	8.1	8.1	6.4	7.0
Feb.	9.1	8.6	8.2	8.1	6.6	7.5
Mar.	9.3	8.9	8.6	8.2	7.2	8.1
Apr.	8.6	8.2	7.9	8.0	6.9	7.6
May	7.9	7.0	6.6	6.8	6.1	6.6
June	7.1	6.1	5.7	5.7	5.2	5.6
July	7.0	5.9	5.2	5.4	4.8	4.9
Aug.	7.4	6.0	5.4	5.6	4.6	4.9
Sept.	8.5	6.6	6.1	6.2	5.5	5.9
Oct.	9.0	5.5	5.8	6.0	5.1	5.6
Nov.	9.0	6.2	5.9	5.9	5.4	5.5
Dec.	8.8	6.4	5.9	5.6	5.0	5.2
<i>Average</i>	8.4	7.0	6.6	6.6	5.7	6.2
1924						
Jan.	8.2	6.8	6.3	6.4	5.3	5.8
Feb.	7.8	6.6	6.2	6.4	5.4	5.8
Mar.	7.5	6.5	6.2	6.5	5.4	5.8
Apr.	7.4	6.5	6.1	6.2	5.2	5.8
May	7.0	6.4	5.9	6.1	5.2	5.6
June	7.1	6.2	5.8	5.9	5.2	5.4
July	7.8	7.0	6.2	6.4	5.2	5.9
Aug.	8.5	7.9	6.8	7.5	6.2	6.2
Sept.	8.9	7.5	6.6	7.2	5.8	6.4
Oct.	9.4	8.3	7.0	8.0	6.0	7.2
Nov.	9.9	8.6	7.2	8.4	6.2	7.1
Dec.	10.6	9.2	7.9	9.1	6.4	7.1
<i>Average</i>	8.3	7.3	6.5	7.0	5.8	6.2
1925						
Jan.	10.6	9.4	8.5	8.9	7.1	7.5
Feb.	9.5	8.7	8.2	8.2	7.0	6.8
Mar.	10.0	9.2	8.5	8.9	7.2	7.9
Apr.	9.8	8.5	8.2	8.1	6.9	7.6
May	9.5	8.4	7.9	8.2	6.9	7.5
June	9.1	8.6	8.2	8.4	7.1	8.0
July	9.8	9.1	8.5	9.0	7.5	8.5
Aug.	10.2	9.1	8.5	8.9	7.5	8.5
Sept.	10.1	9.0	8.3	8.9	7.2	8.4
Oct.	10.0	8.6	8.0	8.6	7.1	8.4
Nov.	9.6	8.9	8.2	8.6	7.1	7.9
Dec.	9.8	8.8	8.4	8.8	7.1	7.9
<i>Average</i>	9.8	8.9	8.3	8.8	7.1	7.9

TABLE II (Concluded)

Month	Choice A White	Yellow	Brown	House	Garbage	Bone Naphtha
1926						
Jan.	9.6	9.0	8.8	8.9	7.1	8.1
Feb.	9.4	8.8	8.0	8.6	6.9	8.0
Mar.	9.1	8.6	7.9	8.5	6.6	7.7
Apr.	8.6	7.9	7.4	8.0	6.4	7.4
May	8.5	7.9	7.2	7.6	6.7	7.5
June	8.9	7.9	7.2	7.9	6.5	7.4
July	8.8	7.7	7.0	7.4	6.3	7.0
Aug.	8.2	7.3	6.9	7.2	6.2	6.9
Sept.	8.2	7.2	6.8	7.1	6.2	6.9
Oct.	8.1	7.2	6.4	6.6	5.9	6.9
Nov.	7.4	6.2	5.7	6.1	5.6	6.2
Dec.	7.2	6.2	5.6	6.0	4.5	5.6
Average	8.5	7.7	7.8	7.5	6.2	7.1
1927						
Jan.	7.2	6.4	5.6	6.1	3.8	5.6
Feb.	7.6	6.9	6.0	6.5	4.0	5.6
Mar.	7.6	6.9	6.2	6.6	4.1	5.6
Apr.	7.2	6.6	5.9	...	4.4	5.6
May	7.5	6.8	6.0	...	4.8	5.7
June	7.4	6.9	6.0	...	4.9	5.7
July	7.4	6.6	6.1	...	4.9	5.7
Aug.	7.4	6.9	6.1	...	5.0	5.7
Sept.	7.6	7.2	6.8	...	5.4	6.1
Oct.	8.9	7.5	6.9	...	5.4	6.1
Nov.	8.5	7.5	6.8	7.1	5.4	6.1
Dec.	8.2	7.4	6.7	7.1	5.9	6.1
Average	7.7	7.0	6.3	6.7	4.8	5.8
1928						
Jan.	8.4	7.6	7.0	7.1	6.1	6.4
Feb.	8.1	7.1	6.5	6.8	6.1	6.1
Mar.	8.1	7.1	6.4	6.8	6.1	6.1
Apr.	8.2	7.5	6.6	7.1	6.1	6.1
May	8.2	7.6	7.1	7.2	6.1	6.1
June	7.9	7.4	7.0	7.2	6.1	6.1
July	7.9	7.5	7.1	7.2	6.2	6.1
Aug.	8.0	7.4	7.1	7.2	6.1	6.1
Sept.	8.5	7.9	7.4	7.7	...	6.1
Oct.	8.9	8.0	7.7	7.8	...	5.9
Nov.	8.8	8.1	7.9	8.2	...	5.9
Dec.	8.8	8.4	8.1	8.2	...	6.1
Average	8.3	7.6	7.2	7.4	6.1	6.1

TABLE III.—MONTHLY PRICES OF DOMESTIC AND FOREIGN TANKAGE, 1920-28*

(A) DOMESTIC CONCENTRATED, CHICAGO (14 TO 15 PER CENT AMMONIA) (dollars per unit) ^a									
Month	1920	1921	1922	1923	1924	1925	1926	1927	1928
Jan.	6.25	2.65	2.88	3.88	3.12	3.00	3.20	3.50	3.80
Feb.	6.25	2.58	3.25	3.76	3.12	3.00	3.20	3.50	3.80
Mar.	6.25	2.25	3.75	3.63	3.12	3.00	3.05	3.50	3.80
Apr.	6.25	2.25	3.12	3.12	2.75	3.00	3.05	3.50	3.80
May	6.75	2.25	2.38	2.75	2.50	2.95	3.05	3.25	3.88
June	7.12	2.00	2.50	2.62	2.52	2.90	3.12	3.08	4.12
July	7.12	1.88	3.25	2.62	2.75	3.00	3.38	3.50	4.25
Aug.	7.12	1.88	3.75	2.62	2.88	3.12	3.50	3.75	4.25
Sept.	7.00	2.00	3.50	3.25	3.00	3.25	3.50	4.00	4.25
Oct.	6.00	2.25	3.25	3.88	3.00	3.25	3.50	4.00	4.37
Nov.	3.98	2.25	3.38	3.88	3.00	3.20	3.50	4.00	4.38
Dec.	2.95	2.62	3.88	3.50	3.00	3.20	3.50	3.80	4.37
<i>Average</i>	<i>6.08</i>	<i>2.24</i>	<i>3.24</i>	<i>3.29</i>	<i>2.90</i>	<i>3.07</i>	<i>3.30</i>	<i>3.62</i>	<i>4.09</i>

(B) SOUTH AMERICAN, TO ARRIVE NEW YORK (dollars per unit) ^b					
Month	1924	1925	1926	1927	1928
Jan. ....	.....	3.80 & .10	4.12 & .10	3.95 & .10	4.89 & .10
Feb. ....	.....	3.60 & .10	4.08 & .10	4.08 & .10	4.75 & .10
Mar. ....	.....	3.55 & .10	3.75 & .10	4.25 & .10	4.62 & .10
Apr. ....	.....	3.50 & .10	3.62 & .10	4.42 & .10	4.45 & .10
May ....	.....	3.62 & .10	4.00 & .10	4.35 & .10	4.58 & .10
June ....	.....	3.80 & .10	4.12 & .10	4.25 & .10	4.75 & .10
July ....	.....	4.02 & .10	4.48 & .10	4.55 & .10	4.88 & .10
Aug. ....	.....	4.30 & .10	4.60 & .10	4.70 & .10	5.00 & .10
Sept.	3.82 & .10	4.40 & .10	4.50 & .10	4.62 & .10	5.00 & .10
Oct.	4.00 & .10	4.48 & .10	4.38 & .10	4.75 & .10	4.97 & .10
Nov.	4.00 & .10	4.38 & .10	4.30 & .10	4.75 & .10	4.95 & .10
Dec.	3.90 & .10	4.12 & .10	4.15 & .10	4.75 & .10	4.92 & .10
<i>Average</i>	.....	<i>3.95 & .10</i>	<i>4.18 & .10</i>	<i>4.45 & .10</i>	<i>4.81 & .10</i>

* Based on spot quotations at close of business Saturday noon from *Oil, Paint, and Drug Reporter*. Figures are the means of high and low of these quotations for the month. Yearly averages are simple averages of means for twelve months. Dots (....) indicate that data are not available.

^a Unit is 1 per cent (20 lbs.) of ammonia in 1 ton of tankage.

^b First figure refers to the price per unit of ammonia contained in tankage, and second figure to the price per unit of bone phosphate; e.g., if tankage analyzed 10 per cent ammonia and 20 per cent bone phosphate, assuming quotation \$4.00 & .10, it would sell for $(10 \times \$4.00) + (20 \times .10)$, or \$42 per ton.

INEDIBLE ANIMAL FATS

TABLE III (Continued)

(C) GARBAGE TANKAGE, CHICAGO (dollars per ton)									
Month	1920	1921	1922	1923	1924	1925	1926	1927	1928
Jan. ....	....^o	8.00	4.12	6.25	5.88	5.88	6.75	5.50	5.50
Feb. ....	....^o	8.00	4.00	6.38	5.88	5.88	6.75	5.50	5.50
Mar. ....	....^o	5.50	4.00	6.38	5.88	6.38	5.50	5.50	5.50
Apr. ....	....^o	5.50	4.00	6.12	5.88	6.75	5.50	5.50	5.50
May ....	....^o	5.50	4.00	6.38	5.88	6.75	5.50	5.50	5.50
June ....	....^o	5.50	5.62	6.00	5.88	6.75	5.50	5.50	5.50
July ....	....^o	5.00	6.12	5.62	5.88	6.75	5.50	5.50	5.50
Aug. ....	....^o	5.00	6.62	5.12	5.88	6.75	5.50	5.50	5.50
Sept. ....	....^o	5.00	6.62	5.50	5.88	6.75	5.50	5.50	5.50
Oct. ....	....^o	6.00	6.25	5.75	5.88	6.75	5.50	5.50	5.50
Nov. ....	....^o	4.00	6.38	5.25	5.88	6.75	5.50	5.50	5.50
Dec. ....	....^o	4.12	6.25	5.12	5.88	6.75	5.50	5.50	5.50
Average	....^o	5.59	5.33	5.82	5.88	6.57	5.71	5.50	5.50

^o Data for 1920 are not satisfactory.

TABLE IV.—TESTS SHOWING YIELDS OF FAT AND CRACKLINGS FROM VARIOUS SORTS OF SLAUGHTERHOUSE OFFALS, SCRAP, AND DEAD ANIMALS, ALL RENDERED BY THE DRY-REDUCTION METHOD
(Data adapted from information made available through the courtesy of W. B. Allbright, of The Allbright-Nell Company, Chicago.)

EDIBLE CUTTING FATS, KILLING FATS, AND SWEET PICKLE FATS AND BONES		INEDIBLE OFFAL FROM 22 POOR-GRADE COWS	
Sweet pickle fats.....	1,808	Head bones	1,036
Sweet pickle ham bones.....	393	Feet	90
Fresh hog blade bones.....	536	Lungs with trachea.....	332
Hog heads stripped.....	1,080	Pecks hashed and washed.....	176
Caul fats	624	Rennets hashed and washed.....	196
Fat backs, with skin on.....	1,143	Rejected livers	247
Fat trimmings from cutting room	440	Caul fat	216
Gullets	460	Gut ends	274
Hog stomachs washed.....	320	Condemed viscera	241
Bung trimming fats.....	780	Bones	70
		Miscellaneous	107
Total	7,584	Total	2,985
Yield of	5,346	Yield of	945
Lard: 70.5%, or.....	773	Grease: 31.7%, or.....	1,036
Pressed cracklings: 10.2%, or...		Pressed cracklings: 34.7%, or...	
EDIBLE CUTTING FATS, ETC., WITHOUT BONES		MIXED CATTLE AND HOG INEDIBLE OFFAL	
Cutting room fats.....	6,492		<i>Pounds</i>
Back fats with skin on.....	865		<i>Hog</i>
Caul fats	434		<i>Beef</i>
Ears	120	Lungs	250
Head trimmings	160	Hashed black guts.....	202
		Head and jaw bones....	1,162
Total	8,071	Floor scraps	187
Yield of	6,214	Beef tallow—guts	581
Lard: 76.0%, or.....	490	Beef tallow—lungs and feet	196
Pressed cracklings: 6.1%, or...		Calf lungs and feet....	76
		Pigs' feet	112
		Total	1,451
		Yield of	1,134
		Grease: 33.6%, or	1,125
		Pressed cracklings:	
		33.4%, or	
BEEF, INEDIBLE		INEDIBLE HOG OFFAL	
Knuckle bones	545		<i>Pounds</i>
Tongue gullets	242	Lungs	424
Sinews and udders	304	Rejected livers	100
Beef guts	353	Stomachs	504
Wind pipes and weasands	250	Catch-basin skimmings	558
Pizzles, rennets, and condemned bruises	394	Hog hair and toes.....	360
Market bones	120	Hog casings	236
Kidneys and flank skin	255	Hashed and washed trimmings...	645
Tripe and tripe trimmings	484	Head bones	495
Broken guts and gut fats	135	Pigs' feet	550
Caul and gut fats	258	Condemed entrails	400
Windpipes, hearts, and livers	118	Bones from cooked pigs.....	90
Neck bones, vertebrae	645	Total	4,361
Total	4,001	Yield of	575
Tallow: 13%, or	720	Grease: 13%, or.....	1,005
Pressed cracklings: 25.7%, or..	1,023	Pressed cracklings: 23%, or.....	

INEDIBLE ANIMAL FATS

TABLE IV (Continued)

DEAD ANIMALS							
Item	Horses	Hogs	Pigs	Cows	Steers	Sheep	Dogs
Number of animals	6½	28	39	10	8	68	125
Total (pounds)							
Weight*	4,909	4,836	2,700	4,239	4,528	2,989	3,500
Yield of fat.....	437	2,107	604	332	630	620	620
Yield of pressed cracklings...	1,315	765	425	1,000	1,150	781	845
Average per animal (pounds)							
Weight	755	173	69	424	566	44	28
Yield of fat.....	67	75	16	33	69	9	4
Yield of pressed cracklings..	202	27	11	100	144	11	7
Percentage of weight							
Yield of fat.....	8.9	43.5	22.4	7.8	11.7	20.7	14.8
Yield of pressed cracklings...	26.5	15.8	15.7	23.5	25.4	26.1	24.1
Analysis of cracklings (per cent)							
Moisture	7.2	9.7	....	....	7.1	....	6.7
Ammonia	11.8	12.8	....	....	12.0	....	13.0

BONES		DEAD-ANIMALS AND SHOP SCRAP	
Total	3,792	Bones from butcher shops (39% of total)	144,000
Yield of		Scrap fats and trimmings from butcher shops (15% of total)...	60,000
Grease: 13.6%, or	514	Suet (9% of total)	36,000
Pressed cracklings, 50.6%, or	1,920	Dead stock, mostly cattle and horses (40% of total)	160,000
		Total	400,000
		Yield of	
		Grease: 20%, or	84,888
		Pressed cracklings: 29.5%, or...	118,200
		Bones and dead animals: 8 to 10% of fat and 23 to 30% of pressed cracklings	
		Shop fats: 50% of fat and 18% of pressed cracklings	
		Suet: 75% of fat and 7% of pressed cracklings	

* Except for dogs, the viscera of the dead animals were removed, and the weights reported for horses and cattle are exclusive of hides as well as viscera.

TABLE V A.—SUMMARY OF COMPARATIVE YIELDS OF CRACKLINGS AND FATS FROM DIFFERENT SORTS OF ANIMAL BY-PRODUCTS*
(Percentage of total weight of raw material)

Product	Pressed cracklings	Grease	Tallow	Lard
<i>Packing-house products</i>				
Edible cutting fats, killing fats, and sweet pickle fats and bones	10.2	....	....	70.5
Edible cutting fats, etc., without bones	6.1	....	....	76.9
Inedible hog offal	23.0	13.0	....	....
Inedible offal from 22 poor-grade cows	34.7	31.7	....	....
Beef, inedible	25.7	....	18.0	....
Mixed cattle and hog inedible offal ...	33.3	33.7	....	....
<i>Dead animals and shop scrap</i>				
Bones and dead animals	23.30	....	8.10	....
Shop fats	18.0	....	50.0	....
Suet	7.0	....	75.0	....
Average	29.5	20.5	....	....
<i>Bones</i>	50.6	13.6	....	....
<i>Dead animals</i>				
Horses	26.5	8.9	....	....
Hogs	15.8	43.5	....	....
Pigs	15.7	22.4	....	....
Cows	23.5	7.8	....	....
Steers	25.4	11.7	....	....
Sheep	26.1	....	20.7	....
Dogs	24.1	14.8	....	....

* For source, see Table IV.

TABLE V B.—ESTIMATED VALUE OF FINISHED MATERIALS OBTAINED FROM DEAD ANIMALS BY DRY-REDUCTION PROCESS*

Per animal	Horses and cows	Calves	Hogs	Dogs, cats, poultry
	WEIGHT (pounds)			
Grease	50	3%	70	....
Cracklings	225	18%	32	....
ESTIMATED VALUE (dollars)				
Grease @ 7c.....	3.50	.26	4.90	....
Cracklings @ \$65.00 per ton.....	7.21	.60	1.04	....
Hides	5.00 ^a	1.00	....	....
<i>Total</i>	15.71	1.86	5.94	....
Estimated value per 100 pounds, unrendered .....	....	....	....	2.00

* Source as for Table IV.

^a Horsehides with tail and mane.

INEDIBLE ANIMAL FATS

TABLE VI.—UNITED STATES EXPORTS OF ANIMAL FATS, 1922-28*

Product	1922	1923	1924	1925	1926	1927	1928
	(A) VOLUME (million pounds)						
GRAND TOTAL	1,031.2	1,288.1	1,217.7	928.0	923.8	897.5	937.3
<i>Edible animal fats, total</i>	925.5	1,178.8	1,092.3	819.3	833.5	796.5	857.0
Lard	787.4	1,059.5	971.5	707.7	717.1	701.7	783.5
Oleo stock	15.6	10.3	13.8	12.2	12.2	11.9	6.8
Oleo oil	109.4	99.0	99.4	92.0	96.9	78.8	62.8
Oleo and lard stearin....	10.7	8.8	6.6	7.4	7.3	5.6	3.9
Tallow, edible	2.4	1.2	1.0	.....^a	.....^a	.....^a	.....^a
<i>Inedible animal fats, oils, greases, and derivatives, total</i>	105.7	109.3	125.4	108.7	90.3	99.5	80.3
Greases and derivatives, total	72.7	72.5	89.2	88.4	77.8	90.7	73.8
Stearic acid	5.0	2.9	2.2	1.9	1.0	2.4	2.3
Oleic acid or red oil....	3.6	1.7	2.7	.5	.9	2.2	6.3
Grease stearin	8.4	3.5	3.0	2.6	2.4	3.4	1.5
Lard oil .....	.7	.7	.5	.....^b	.....^b	.....^b	.....^b
Other animal oils.....	2.5	2.3	1.4	2.1	.7	.9	.7
Other animal fats, oils, and greases	57.5	61.4	79.4	81.3	72.8	81.8	63.0
Tallow	29.0	33.9	33.0	17.5 ^a	10.6 ^a	6.6 ^a	3.2 ^a
Neatsfoot oil	1.1	1.1	1.8	1.4	1.1	1.5	1.2
Glycerin	2.9	1.8	1.4	1.4	.8	.7	2.1

* Data for 1922-27 from *Foreign Commerce and Navigation of the United States*, for 1928 from *Monthly Summary of Foreign Commerce of the United States*. As officially reported, data prior to 1922 are of little value owing to frequent shifts in classification and changing combinations of the several items.

^a Edible tallow reported under "tallow" after 1924. The great bulk of this item is evidently of the inedible grade.

^b Lard oil included in "other animal oils" after 1924.

TABLE VI (Continued)

Product	1922	1923	1924	1925	1926	1927	1928
(B) VALUE (thousand dollars)							
GRAND TOTAL	116,343	157,280	158,085	146,405	134,615	115,691	118,980
<i>Edible animal fats, total...</i>	108,303	147,389	146,416	135,941	125,738	106,612	111,505
Lard	94,072	138,333	129,761	121,638	111,648	96,038	101,926
Oleo stock	1,523	1,173	1,711	1,528	1,481	1,378	982
Oleo oil	11,465	11,841	14,113	11,814	11,786	9,699	8,281
Oleo and lard stearin.....	1,060	942	753	961	874	597	436
Tallow, edible	198	100	88	.....^a	.....^a	.....^a	.....^a
<i>Inedible animal fats, oils, greases, and derivatives, total</i>	8,040	9,901	11,669	12,464	8,877	9,079	7,475
<i>Greases and derivatives, total</i>	5,420	6,585	8,343	10,305	7,529	8,136	6,713
Stearic acid	481	868	255	233	139	240	257
Oleic acid or red oil....	290	145	226	51	86	191	547
Grease stearin	277	333	803	296	270	337	114
Lard oil	80	88	56	.....^b	.....^b	.....^b	.....^b
Other animal oils.....	243	197	174	281	80	102	82
Other animal fats, oils, and greases	4,049	5,464	7,329	9,394	6,964	7,266	5,718
Tallow	2,018	2,789	2,511	1,624 ^a	958 ^a	563 ^a	237 ^a
Neatsfoot oil	176	198	277	253	196	236	216
Glycerin	426	319	238	282	192	144	269

TABLE VII.—UNITED STATES IMPORTS (FOR CONSUMPTION) OF ANIMAL FATS, 1922-28*

Product	1922	1923	1924	1925	1926	1927	1928
(A) VOLUME (thousand pounds)							
GRAND TOTAL	31,069	36,319	32,610	35,560	68,011	51,257	38,602
<i>Edible, total</i>	293	226	1,058	939	2,043	2,887	2,249
Lard .....	.....^a	4	49	38	83	6	3
Oleo stearin	293	216	1,009	901	1,960	2,064	1,622
Oleo oil .....	.....	6	.....	.....	.....^a	817	624
<i>Inedible, total</i>	30,776	36,093	31,552	34,621	65,968	48,370	36,353
Tallow							
Beef	} 1,831	10,823	} 2,272	1,773	18,022	10,885	12,861
Mutton .....								169	55	625	1,063	1,378
Greases and derivatives							
Stearic acid	35	470	266	1,266	1,770	1,022	2,008
Oleic acid or red oil.....	19	11	37	33	31	79	46
Wool grease							
Crude	13,364	8,310	11,633	9,112	10,498	9,010	8,298
Refined and improved...	500	1,121	1,111	856	1,299	1,917	2,371
All other animal oils, fats, and greases	11,262	223	136	216	225	145	262
Glycerin							
Crude	3,604	14,549	14,427	19,268	27,659	14,944	4,916
Refined	161	586	1,501	2,044	10,839	8,315	4,218
(B) VALUE (thousand dollars)							
GRAND TOTAL	1,519.7	2,718.4	2,481.6	3,359.8	8,479.9	5,650.1	2,743.2
<i>Edible, total</i>	25.8	21.5	118.9	112.8	225.0	255.5	222.5
Lard .....	.....^a	.6	9.1	7.6	9.2	1.0	.7
Oleo stearin	25.8	20.4	109.8	105.2	215.7	187.6	144.4
Oleo oil .....	.....	.5	.....	.....	.1	66.9	77.4
<i>Inedible, total</i>	1,484.9	2,696.9	2,362.7	3,247.0	8,254.9	5,394.6	2,520.7
Tallow							
Beef	} 125.4	831.5	} 196.8	177.7	1,164.5	787.2	1,001.9
Mutton .....								10.5	4.9	52.7	138.1	102.8
Greases and derivatives							
Stearic acid	8.9	52.8	31.6	156.0	223.3	105.8	226.3
Oleic acid or red oil.....	2.1	1.8	4.2	4.6	5.1	7.1	5.9
Wool grease							
Crude	341.1	214.0	298.9	296.7	373.1	279.5	202.6
Refined and improved...	24.7	77.3	78.9	50.3	96.1	150.4	156.8
All other animal oils, fats, and greases	612.3	18.3	13.3	14.6	15.0	10.8	18.3
Glycerin							
Crude	347.1	1,429.7	1,490.6	2,236.4	3,996.2	2,215.1	335.9
Refined	28.8	77.0	229.9	305.8	2,328.9	1,100.8	450.2

* Data from *Foreign Commerce and Navigation of the United States*. Dots (....) indicate that data are not available.

^a Imports negligible.

TABLE VIII.—UNITED STATES EXPORTS OF PRODUCTS DERIVED FROM ANIMAL OFFALS (EXCLUDING FATS), 1922-28*

Product	1922	1923	1924	1925	1926	1927	1928
(A) VOLUME (thousand pounds)							
<i>Total</i>	35,307	29,394	48,968	47,165	40,390	40,637	42,469
Bones, hoofs, and horns, un- manufactured	5,927	6,389	4,434	3,775	1,996	1,806	2,370
Boneblack and lampblack..	2,057	3,019	1,972	3,805	3,529	3,016	3,751
Gelatin	259	262	422	461	282	307	244
Sausage casings	24,355	17,214	39,997	36,678	32,120	33,156	33,067
Glue of animal origin.....	2,709	2,510	2,173	2,546	2,463	2,352	2,547
All other animal products, inedible .....	.....	.....	.....	.....	.....	.....	.....
(B) VALUE (thousand dollars)							
<i>Total</i>	7,042	5,808	9,101	10,969	10,889	9,830	10,905
Bones, hoofs, and horns, un- manufactured	261	339	201	149	79	72	112
Boneblack and lampblack..	117	181	123	250	242	189	219
Gelatin	176	180	297	299	214	198	159
Sausage casings	5,647	4,312	7,711	9,135	8,104	6,826	6,780
Glue of animal origin.....	419	386	348	325	381	384	426
All other animal products, inedible	423	402	421	754	1,869	2,161	2,309

* Data for 1922-27 from *Foreign Commerce and Navigation of the United States*; for 1928 from *Monthly Summary of Foreign Commerce of the United States*. Dots (.....) indicate that data are not available.

INEDIBLE ANIMAL FATS

TABLE IX A.—UNITED STATES IMPORTS (FOR CONSUMPTION) OF PRODUCTS DERIVED FROM ANIMAL OFFALS (EXCLUDING FATS), 1922-28*

VOLUME (thousand pounds)

Product	1922	1923	1924	1925	1926	1927	1928
GRAND TOTAL	499,831	576,681	463,778	554,803	621,108	618,701	761,310
<i>Feeds and fertilizers, total.</i>	365,550	395,478	302,604	395,928	424,158	400,816	561,057
Dried blood	20,523	28,542	16,117	22,823	25,563	26,864	19,022
Tankage .....	.....	.....	48,646	67,334	55,032	49,284	86,833
Other nitrogenous material, including fish scrap, hoof meal, etc...	52,604	168,497	106,075	163,050	124,291	120,124	165,222
Bone phosphates (bone ash, dust, and meal) and animal carbon....	72,294	121,280	49,822	55,957	104,642	122,273	164,920
Other substances used only for manure	220,129	77,159	81,944	86,764	114,630	82,271	125,060
<i>Bones, glue, gelatin, and similar products, total.</i>	117,200	159,981	141,288	138,037	177,729	196,601	182,175
Bones, crude, steamed, or ground	76,725	110,973	98,440	94,496	118,008	138,368	117,665
Hoofs, horns, horn strips and tips	3,405	4,360	1,760	1,247	841	744	1,124
Bone black, bone char, and blood char.....	236	723	568	2,434	1,694	481	1,017
Glue stock, hide cuttings, etc.	27,390	32,329	27,983	29,757	45,856	43,372	48,567
Glue and glue size.....	6,097	6,607	7,422	5,175	6,905	9,145	9,183
Manufactures of glue and glue size	1	11	32	90	18	17	37
Gelatin, edible	639	2,918	3,272	3,171	2,385	2,479	1,962
Gelatin, inedible	2,525	1,656	1,456	1,532	1,827	1,431	1,468
Manufactures of gelatin, inedible	182 ^a	504	355	136	196	504	1,152
<i>Other products, total.....</i>	17,081	21,222	19,886	20,838	19,221	21,284	18,078
Bladders, intestines, integuments, and tendons.	823	962	1,087	1,126	521	890	53
Sausage casings	15,997	19,984	18,639	19,516	18,533	20,755	17,916
Rennets	261	328	160	196	167	139	109

* Data from *Foreign Commerce and Navigation of the United States*. Dots (...) indicate that data are not available.

^a Partially estimated.

TABLE IX B.—UNITED STATES IMPORTS (FOR CONSUMPTION) OF PRODUCTS DERIVED FROM ANIMAL OFFALS (EXCLUDING FATS), 1922-28*

VALUE (thousand dollars)

Product	1922	1923	1924	1925	1926	1927	1928
GRAND TOTAL	18,913	25,081	22,023	30,813	27,958	26,995	27,179
<i>Feeds and fertilizers, total.</i>	<i>4,798</i>	<i>5,331</i>	<i>3,450</i>	<i>5,196</i>	<i>5,173</i>	<i>4,947</i>	<i>8,153</i>
Dried blood	568	841	404	588	707	690	667
Tankage .....	...	...	676	1,018	1,009	847	1,286
Other nitrogenous material, including fish scrap, hoof meal, etc...	710	1,918	1,085	1,941	1,425	1,195	2,502
Bone phosphates (bone ash, dust, and meal) and animal carbon.....	861	1,691	707	725	1,380	1,541	2,567
Other substances used only for manure.....	2,664	881	578	924	652	668	1,181
<i>Bones, glue, gelatin, and similar products, total.</i>	<i>4,241</i>	<i>5,362</i>	<i>4,738</i>	<i>4,636</i>	<i>5,492</i>	<i>5,948</i>	<i>6,349</i>
Bones, crude, steamed, or ground	837	1,387	1,046	1,002	1,350	1,686	1,161
Hoofs, horns, horn strips and tips	259	304	186	117	84	64	65
Bone black, bone char, and blood char.....	82	18	45	50	82	8	35
Glue stock, hide cuttings, etc.	1,068	1,303	1,053	1,401	1,767	1,845	2,341
Glue and glue size.....	737	568	574	437	528	692	800
Manufactures of glue and glue size	2	2	6	11	7	6	5
Gelatin, edible	198	844	695	655	494	494	442
Gelatin, inedible	928	489	805	830	1,040	759	815
Manufactures of gelatin, inedible	184	447	330	133	140	404	685
<i>Other products, total.....</i>	<i>9,874</i>	<i>14,368</i>	<i>13,835</i>	<i>20,981</i>	<i>17,293</i>	<i>16,100</i>	<i>12,577</i>
Bladders, intestines, integuments, and tendons.	206	755	1,076	1,868	668	180	42
Sausage casings	9,574	13,546	12,699	19,006	16,493	15,832	12,585
Rennets	95	87	60	107	132	88	50

* For source and footnotes see Table IX A.

INEDIBLE ANIMAL FATS

TABLE X.—COMPARISON OF COMPUTED AND REPORTED DOMESTIC CONSUMPTION OF INEDIBLE TALLOW, 1922-27*

(Million pounds)

Item	1922	1923	1924	1925	1926	1927
Production	362.8	384.0	388.3	378.5	425.2	404.2
Stocks on hand, Jan. 1	94.6	63.3	69.0	61.4	51.9	84.1
Imports for consumption	1.8	10.8	2.4	1.8	13.6	12.9
Total available for consumption..	459.2	458.1	459.7	441.7	490.7	501.2
Stocks on hand, Dec. 31	63.3	69.0	61.4	51.9	84.1	77.0
Exports	29.0	33.9	33.0	17.5 ^c	10.6 ^c	6.6 ^c
Total deductions	92.3	102.9	94.4	69.4	94.7	83.6
Computed domestic consumption ..	366.9	355.2	365.3	372.3	396.0	417.6
Reported domestic consumption	463.9	465.9	516.4	479.0	507.2	574.0
Apparent understatement of domestic production^b	97.0	110.7	151.1	106.7	111.2	156.4

* Data for production, stocks, and "reported consumption" from U.S. Bureau of the Census, *Animal and Vegetable Fats and Oils*; imports and exports from *Foreign Commerce and Navigation of the United States*.

^c Includes edible tallow of which the proportion is small (see Table VI).

^b The actual understatement is probably still larger because of the exclusion of the output of small producers in the official data on production.

TABLE XI.—PRODUCTION OF GREASE DERIVATIVES, 1922-28*

(Million pounds)

Product	1922	1923	1924	1925	1926	1927	1928
GRAND TOTAL^{a,b}	126.5	172.0	154.1	151.7	147.0	148.3	161.2
<i>Red oil and stearic acid, total</i>	<i>68.1</i>	<i>73.1</i>	<i>69.3</i>	<i>78.3</i>	<i>82.6</i>	<i>92.0</i>	<i>108.7</i>
Red oil	44.3	45.2	45.0	50.4	49.9	55.7	64.4
Stearic acid	23.8	27.9	24.3	27.9	32.7	36.3	44.3
<i>Oil and stearin, total.....</i>	<i>58.4</i>	<i>98.9</i>	<i>84.8</i>	<i>73.4</i>	<i>64.4</i>	<i>56.3</i>	<i>52.5</i>
Lard oil	26.0	34.3	29.2	35.4	28.6	26.7	22.2
Tallow oil ^c	12.0	36.3	30.4	11.9	12.8	12.5	11.2
Inedible animal stearin ^b	20.4	28.3	25.2	26.1	23.0	17.1	19.1

* Data from U.S. Bureau of the Census, *Animal and Vegetable Fats and Oils*, 1922-28.

^a Includes a small proportion of tallow derivatives. Most of the so-called "tallow oil" is stated by the trade to be in fact produced from grease.

^b The quantity of grease used in the production of derivatives is somewhat larger than the total production of such derivatives, because of a small by-product of glycerin, tar, and loss of moisture.

TABLE XII.—COMPARISON OF COMPUTED AND REPORTED CONSUMPTION OF PACKERS' AND RENDERERS' GREASES, 1922-27*
(Million pounds)

Item	1922	1923	1924	1925	1926	1927
Production ^a	860.0	886.8	376.5	840.6	846.7	869.1
Stocks on hand, Jan. 1.....	76.8	37.6	53.2	37.8	38.2	46.1
Imports for consumption	11.3	.2	.1	.2	.2	.1
Total available for consumption..	447.1	424.6	429.8	378.6	885.1	415.3
Stocks on hand, Dec. 31.....	37.6	53.2	37.8	38.2	46.1	48.3
Exports	57.5	61.4	79.4	81.3	72.8	81.8
Total deductions	95.1	114.6	117.2	119.5	118.9	130.1
Computed domestic consumption ...	352.0	310.0	312.6	259.1	266.2	285.2
Reported domestic consumption	232.0	251.4	231.4	227.4	225.9	204.9
Apparent understatement of domestic production ^a	120.0	58.6	81.2	31.7	40.3	80.3

* Data for production, stocks, and "reported domestic consumption" from U.S. Bureau of the Census, *Animal and Vegetable Fats and Oils*; imports and exports from *Foreign Commerce and Navigation of the United States*, showing (see Tables VI and VII) "all other animal fats, oils, and greases." Since other animal fats except grease are specifically enumerated, it is inferred that this catch-all item consists almost entirely of grease.

^a These reports were inaugurated in 1919, and in later years a more comprehensive list of consumers was obtained by the Census Bureau. Nevertheless, the data on production do not include the output of numerous small producers. The reported domestic consumption is certainly understated, as may be shown by the following figures in million pounds for consumption by the soap industry and manufacturers of grease derivatives:

	1922	1923
Consumption by the soap industry (see Table 20).....	142.0	140.3
Consumption by producers of grease derivatives (see Table XI)	126.5	172.0
Total	268.5	312.3
Reported domestic consumption.....	232.0	251.4

Substantial quantities are also exported, used in lubricants, in dressing leather, and in many other products.

INEDIBLE ANIMAL FATS

TABLE XIII.—RATIO OF ANNUAL SLAUGHTER TO LIVESTOCK POPULATION, 1907-28*

Year	Cattle and calves			Sheep and lambs			Hogs		
	Number of animals (Millions)	Number slaughtered (Millions)	Percentage slaughtered	Number of animals (Millions)	Number slaughtered (Millions)	Percentage slaughtered	Number of animals (Millions)	Number slaughtered (Millions)	Percentage slaughtered
1907.....	68.2	19.5	28.6	42.7	13.4	31.4	61.3	54.1	88.3
1908.....	66.0	18.9	28.6	43.5	13.5	31.0	64.2	60.5	94.2
1909.....	64.8	20.1	31.0	44.8	14.7	33.2	63.4	58.2	83.9
1910.....	62.0	20.1	32.4	44.8	14.8	33.0	57.2	47.1	82.3
1911.....	60.7	19.2	31.6	45.7	18.1	39.6	63.7	56.6	88.9
1912.....	58.2	18.3	31.4	44.6	19.2	43.0	62.7	55.6	88.7
1913.....	56.8	16.8	29.6	43.7	18.5	42.3	57.9	57.0	98.4
1914.....	56.8	15.7	27.6	42.2	18.3	43.4	55.0	55.5	100.9
1915.....	58.6	15.5	26.5	42.2	15.8	37.4	59.6	62.0	104.0
1916.....	62.2	17.8	28.6	41.1	15.4	37.5	61.7	67.6	109.6
1917.....	64.9	20.8	32.0	40.2	12.1	30.1	60.7	56.9	93.7
1918.....	67.8	23.3	34.4	40.9	13.4	32.8	63.0	64.8	102.9
1919.....	69.0	23.3	33.8	41.1	16.3	39.7	65.3	65.2	99.8
1920.....	68.8	22.3	32.4	40.7	14.2	34.9	62.5	61.9	99.0
1921.....	67.4	20.0	29.7	39.1	16.7	42.7	61.3	63.0	102.8
1922.....	67.7	21.5	31.8	36.6	14.1	38.5	62.0	63.1	109.8
1923.....	65.7	22.7	34.6	36.6	14.9	40.7	71.5	79.8	111.6
1924.....	64.7	23.9	36.9	37.3	15.4	41.3	68.8	79.6	115.7
1925.....	63.5	24.8	39.1	38.5	15.5	40.3	58.2	68.3	117.4
1926.....	60.5	24.5	40.5	40.2	16.7	41.5	54.4	65.8	121.0
1927.....	58.2	23.0	39.6	42.3	16.6	39.2	56.8	69.2	121.8
1928.....	57.4	21.1	36.7	45.1	17.3	38.4	63.1	76.6	121.4

* Data for number of animals from *Agriculture Yearbook, 1928*, pp. 902, 921, 939, 973; estimates of slaughter from U.S. Department of Agriculture, Bureau of Animal Industry, *Meat Production, Consumption, and Foreign Trade in United States, 1900-1928*. Data for number of animals are as of January 1. Percentages are computed. As previously stated (pp. 154-74), official estimates of slaughter outside of federal inspection are rough approximations.

TABLE XIV.—NUMBER OF ANIMALS SLAUGHTERED UNDER FEDERAL INSPECTION AND ESTIMATES OF OTHER AND TOTAL SLAUGHTER (INCLUDING FARM), 1907-28*

(Thousand animals)

Year	Estimated total slaughtered	Federally inspected	Other	Percentage federally inspected	Estimated total slaughtered	Federally inspected	Other	Percentage federally inspected
CATTLE					CALVES			
1907	13,287	7,638	5,654	57.4	6,211	2,024	4,187	32.6
1908	12,852	7,279	5,573	56.6	6,048	1,958	4,090	32.4
1909	13,611	7,714	5,897	56.7	6,516	2,189	4,327	33.6
1910	13,541	7,807	5,734	57.7	6,553	2,238	4,315	34.2
1911	12,958	7,619	5,339	58.8	6,264	2,184	4,080	34.9
1912	11,979	7,253	4,726	60.5	5,348	2,278	4,070	35.9
1913	11,478	6,978	4,500	60.8	5,225	1,902	3,323	36.0
1914	11,004	6,757	4,247	61.4	4,661	1,697	2,964	36.4
1915	10,822	7,158	3,669	66.1	4,640	1,819	2,821	39.2
1916	12,027	8,310	3,717	69.1	5,774	2,367	3,407	41.0
1917	13,724	10,350	3,374	75.4	7,031	3,143	3,888	44.7
1918	15,750	11,829	3,921	75.1	7,514	3,456	4,058	46.0
1919	14,838	10,091	4,747	68.0	8,445	3,909	4,476	47.0
1920	13,885	8,609	5,276	62.0	8,455	4,058	4,397	48.0
1921	12,271	7,608	4,668	62.0	7,771	3,806	3,963	49.0
1922	13,148	8,678	4,470	66.0	8,363	4,182	4,181	50.0
1923	13,883	9,163	4,720	66.0	8,324	4,500	4,324	51.0
1924	14,400	9,593	4,807	66.6	9,466	4,935	4,531	52.1
1925	14,706	9,853	4,853	67.0	10,009	5,353	4,746	53.0
1926	14,971	10,180	4,791	68.0	9,542	5,153	4,389	54.0
1927	14,000	9,520	4,480	68.0	9,030	4,876	4,154	54.0
1928	12,452	8,487	3,985	68.0	8,667	4,680	3,987	54.0
SHEEP AND LAMBS					SWINE			
1907	13,360	10,252	3,106	76.7	54,058	32,885	21,173	60.8
1908	13,528	10,304	3,222	76.2	60,515	38,643	21,872	63.9
1909	14,725	11,342	3,383	77.0	53,220	31,395	21,825	59.0
1910	14,797	11,408	3,389	77.1	47,076	26,014	21,062	55.3
1911	13,657	14,020	4,037	77.6	56,646	34,133	22,513	60.3
1912	19,247	14,979	4,268	77.8	55,564	33,053	22,511	59.5
1913	18,520	14,406	4,114	77.8	57,046	34,199	22,847	59.9
1914	18,290	14,229	4,061	77.8	55,501	32,532	22,969	58.6
1915	15,756	12,212	3,544	77.5	62,017	38,381	23,636	61.9
1916	15,408	11,941	3,467	77.5	67,613	43,084	24,529	63.7
1917	12,149	9,345	2,804	76.9	56,901	33,910	22,991	59.6
1918	13,359	10,320	3,039	77.3	64,796	41,214	23,582	63.6
1919	16,317	12,691	3,626	77.8	65,190	41,812	23,378	64.1
1920	14,180	10,982	3,198	77.4	61,890	38,019	23,871	61.4
1921	16,710	13,005	3,705	77.8	62,967	38,982	23,976	61.9
1922	14,112	10,929	3,182	77.4	68,106	43,114	24,991	63.3
1923	14,862	11,529	3,333	77.6	79,843	53,334	26,509	66.8
1924	15,441	11,991	3,451	77.7	79,631	52,373	26,758	66.4
1925	15,454	12,001	3,453	77.7	68,294	43,043	25,251	63.0
1926	16,689	12,961	3,728	77.7	65,779	40,636	25,143	61.8
1927	16,589	12,833	3,706	77.7	60,250	43,633	25,617	63.0
1928	17,348	13,488	3,860	77.7	76,593	49,795	28,798	65.0

* Data from U.S. Department of Agriculture, Bureau of Animal Industry, *Meat Production, Consumption, and Foreign Trade in United States, 1920-1928*. Percentages are computed. Official estimates of total and non-federally inspected slaughter are rough approximations, subject to a wide margin of error (see pp. 154-74).

INEDIBLE ANIMAL FATS

TABLE XV.—UNITED STATES IMPORT DUTIES AND TARIFF CLASSIFICATIONS: ANIMAL FATS AND PRODUCTS DERIVED FROM ANIMAL OFFALS, ACTS OF 1909, 1913, AND 1922*

Product	Act of	Paragraph	Included under	Rate of duty
Tallow	1909	290	"tallow"	½ cent per lb.
	1913	622	"tallow"	Free
	1922	701	"tallow"	½ cent per lb.
Oleo oil	1909	8	"expressed oils, n.s. p.f."	25% ad valorem
	1913	44	"all other animal oils, n.s.p.f."	15% ad valorem
	1922	701	"oleo oil"	1 cent per lb.
Oleo stearin	1909	640	"oleo stearin"	Free
	1913	562	"oleo stearin"	Free
	1922	701	"oleo stearin"	1 cent per lb.
Lard	1909	288	"lard"	1½ cents per lb.
	1913	528	"lard"	Free
	1922	703	"lard"	1 cent per lb.
Red oil or oleic acid	1909	1	"oleic acid or red oil"	1½ cents per lb.
	1913	1	"all other acids, n.s. p.f."	25% ad valorem
	1922	1	"all other acids, n.s. p.f."	15% ad valorem
Stearic acid	1909	1	"stearic acid"	1½ cents per lb.
	1913	1	"all other acids, n.s. p.f."	25% ad valorem
	1922	1	"all other acids, n.s. p.f."	15% ad valorem
Animal greases; neatsfoot oil, grease oils, and grease stearin	1909	580	"grease, fats, and oils (except fish oils) such as are commonly used in soap-making or in wire-drawing or for stuffing or dressing leather, and which are fit only for such uses, n.s.p.f."	Free
				1913	498	"grease, fats, and oils (except fish oils), not chemically compounded, such as are commonly used in soap-making or in wire-drawing or for stuffing or dressing leather, n.s.p.f."	Free
	1922	53	"all other animal oils, fats, and greases, n.s.p.f."	20% ad valorem

* U.S. Tariff Commission, *Comparison of Tariff Acts, 1922*.

TABLE XV (Continued)

Product	Act of	Para-graph	Included under	Rate of duty
Tankage, cracklings, meat meal	1909	581	"all substances used only for manure"	Free
	1918	499	"all substances used only for manure"	Free
	1922	1589	"all other substances used chiefly for fertilizer, n.s.p.f."	Free
Bones, bone meal, animal carbon	1909	515	"Bones, crude, or not burned, calcined, ground, steamed, or otherwise manufactured, and bone dust or animal carbon, and bone ash, fit only for fertilizing purposes"	Free
	1913	423	"Bones, crude ground, steamed and bone dust or animal carbon, bone meal, and bone ash"	Free
	1922	1526	"Bones: crude, steamed or ground; bone dust, bone meal, and bone ash; and animal carbon suitable for fertilizing purposes"	Free
Bone black or bone char	1909	43	"Bone char, suitable for use in decolorizing sugar, and blood char"	20% ad valorem
	1918	447	"Blood char, bone char, or bone black, not suitable for use as a pigment"	Free
	1922	71	"Bone black or bone char, blood char, and decolorizing and deodorizing chars or carbons"	20% ad valorem

INEDIBLE ANIMAL FATS

TABLE XV (Continued)

Product	Act of	Para-graph	Included under	Rate of duty
Sausage casings, intestines, bladders, tendons, etc.	1909	512	"Bladders, and all integuments, tendons and intestines of animals crude, dried or salted for preservation only, and unmanufactured, n.s. p.f."	Free
	1913	419	"Bladders, and all integuments, tendons and intestines of animals crude, dried, or salted for preservation only, and unmanufactured, n.s. p.f."	Free
	1922	1655	"Sausage casings, weasands, intestines, bladders, tendons, and integuments, n.s.p.f."	Free
Blood, dried	1909	257 and 513	"Blood, dried, n.s. p.f."	1½ cents per lb. when soluble; otherwise free
	1913	420	"Blood, dried, n.s. p.f."	Free
	1922	1524	"Blood, dried, n.s. p.f."	Free
Rennets	1909	662	"Rennets, raw or prepared"	Free
	1913	688	"Rennets, raw or prepared"	Free
	1922	1652	"Rennets, raw or prepared"	Free
Glue stock	1909	584	"Hide cuttings, raw, with or without hair, and all other glue stock"	Free
	1913	504	"Hide cuttings, raw, with or without hair, and all other glue stock"	Free
	1922	1587	"Hide cuttings, raw, with or without hair, osseon, and all other glue stock"	Free

* Under the Act of 1913, beef weasands were held to be dutiable as non-enumerated, unmanufactured articles at 10 per cent ad valorem, and not free of duty under paragraph 419 as "integuments, tendons, and intestines of animals."

TABLE XV (Continued)

Product	Act of	Para- graph	Included under	Rate of duty
Hoofs	1909	587	"Hoofs, unmanufactured"	Free
	1913	508	"Hoofs, unmanufactured"	Free
	1922	1591	"Hoofs, unmanufactured"	Free
Horns	1909	589	"Horns and parts of; including horn strips and tips, unmanufactured"	Free
	1913	511	"Horns and parts of; including horn strips and tips, unmanufactured"	Free
	1922	1592	"Horns and parts of; including horn strips and tips, unmanufactured"	Free
Hides	1909	450	"Hides of cattle, raw or uncured, whether dry, salted or pickled"	Free
	1913	506	"Hides of cattle, raw or uncured, or dry, salted, or pickled"	Free
	1922	1589	"Hides of cattle, raw or uncured, or dried, salted, and pickled"	Free
Skins	1909	676	"Skins of all kinds, raw (except sheep skins with the wool on), and hides n.s. p. f."	Free
	1913	608 and 604	"Skins of all kinds, raw, and hides, n. s. p. f."	Free
	1922	1666	"Skins of all kinds, raw, and hides, n. s. p. f."	Free

INEDIBLE ANIMAL FATS

TABLE XV (Concluded)

Product	Act of	Para-graph	Included under	Rate of duty
Gelatin, glue, glue size	1909	23	"Gelatin, glue, . . . glue size"	Glue size 25% ad valorem. Gelatin and glue dutiable at rates varying with value of the product ^b
	1913	34	"Gelatin, glue and glue size"	Dutiable at rates varying with value of the product ^c
	1922	42	"Edible gelatin. . . ; gelatin, glue, and glue size"	Dutiable at varying rates, according to value of product ^d
Glycerine	1909	24	"Glycerine, crude, not purified"	1 cent per lb.
			"Glycerine, refined"	3 cents per lb.
	1913	35	"Glycerine, crude, not purified"	1 cent per lb.
			"Glycerine, refined"	2 cents per lb.
	1922	43	"Glycerine, crude"	1 cent per lb.
			"Glycerine, refined"	2 cents per lb.

^b Act of 1909: Gelatin, glue . . . valued at not above 10 cents per lb., 2½ cents per lb.; valued at 10 to 35 cents per lb., 25 per cent ad valorem; valued above 35 cents per lb., 15 cents per lb. and 20 per cent ad valorem.

^c Act of 1913: Gelatin, glue, and glue size, valued at not above 10 cents per lb., 1 cent per lb.; valued at 10 to 25 cents per lb., 15 per cent ad valorem; above 25 cents per lb., 25 per cent ad valorem.

^d Act of 1922: Edible gelatin, valued at less than 40 cents per lb., 20 per cent plus 3½ cents per lb.; at 40 cents or more, 20 per cent ad valorem plus 7 cents per lb. Gelatin, glue, glue size, 20 per cent plus 1½ cents per lb. when valued at less than 40 cents per lb.; 20 per cent plus 7 cents per lb. when valued at 40 cents and over.

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