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AN INVESTIGATION OF FARM OR DAIRY BUTTERMAKING.

DISSERTATION

by

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P R E F A C E .

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This investigation which was begun in June 1909 had for its object the collection of data concerning the manufacture of farm butter in the United States, and is to serve as a basis for future study. This and subsequent investigations have as their final object an improvement of the quality of dairy butter.

The present dissertation is, however, concerned only with the following:

1. The conditions favoring cleanliness on farms.
2. The methods followed in care of cream and manufacture of butter.
3. The facilities on farms favoring improvement.
4. A study of the composition of farm butter.

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### Introduction.

Butter is one of the oldest articles of diet which is being manufactured to-day. Hayward, in collecting data concerning the history of butter, found it mentioned in the Vedas - written 2,000 to 1,400 B. C. Its importance at that time is uncertain but reports show that later its manufacture was practiced in countries which to-day have but few dairy interests. It has been used during the past for various purposes but probably never reached the importance commercially that it has at present. In addition to being a food, it was formerly used as an object for sacrifice in worship, a remedy for injuries to the skin, a hair dressing, an ointment for the body, an oil for lamps, and as an indication of wealth.

It was not, however, until recent years that dairy farming and manufacture of butter took the important place that it now holds in agricultural science and practice. It was not until the establishment of agricultural schools and colleges that an effort was made to improve methods and product. The effort is now being made in all dairy sections and is due largely to the advance of agricultural science and the dissemination of knowledge through colleges, agricultural news papers, bulletins and circulars.

The present demand for butter as a food is such that it has proven profitable to increase the study of conditions affecting its quality and to improve methods in order that a better and more uniform product may be offered to the market and consumer. The demands of that market and its resulting classification of butter will enable a better understanding of the importance and position of dairy or farm butter on the American markets. The demands of the leading butter

markets of the United States vary but little and are largely determined by the requirements as stated by the New York Merchantile Exchange, which are as follows:

**Market Classification of Butter.**

"1. Butter shall be classified as creamery, process, factory, packing stock, and grease butter.

**Definition of Terms Used in Classification.**

"2. Creamery - Butter offered under this classification shall have been made in a creamery from cream separated at the creamery or gathered from farms.

"3. Process - Butter offered under this classification shall be such as is made by melting butter, clarifying the fat therefrom and re-churning the same with fresh milk, cream, or skim-milk, or other similar process.

"4. Factory - Butter offered under this classification shall be such as is collected in rolls, lumps, or in whole packages and reworked by the dealer or shipper.

"5. Packing stock - Butter offered under this classification shall be original farm made butter in rolls, lumps or otherwise, without additional moisture or salt.

"6. Grease butter - This shall comprise all classes of butter grading below thirds, or of packing stock grading below No. 3 as hereinafter specified.

**Grades Under Each Class.**

"7. Creamery, process, and factory shall be graded as Specials, Extras, Firsts, Seconds, and Thirds; and Packing Stock shall be graded as No. 1, No. 2 and No. 3.

**Definition or Requirements of Grades.**

"8. Grades of butter must conform to the following requirements of score as hereinafter provided.

"9. Specials - Shall comprise the highest grades of butter obtainable in the season when offered, under the various classifications. Ninety per cent shall conform to the following standard, the balance shall not grade below extras.

"Flavor - must be fine, sweet, clean, and fresh, if of current make, and fine, sweet and clean if held.

"Body - must be firm and uniform.

"Color - must be <sup>a</sup>light straw shade even and uniform.

"Salt - must be medium salted.

"Package - must be sound, good, uniform, and clean.

Specials may also comprise such lots of Extras as, owing to some particular and unusual qualifications, are more desirable than plain "Extras" offered without any qualifications.

"10. Extras - Shall be a grade just below specials and must be fine butter for the season when made and offered under the various classifications. Ninety per cent shall conform to the following standard: the balance shall not grade below "Firsts."

Flavor - must be sweet, clean and fresh if of current make, and sweet and clean if held.



Body - must be good and uniform.

Color - a light straw shade, even and uniform.

Salt - medium salted.

Package - sound, good, uniform, and clean.

"11. Firsts - Shall be a grade just below Extras and must be good butter for the season when made and offered under the various classifications.

Ninety per cent shall conform to the following standard; the balance shall not grade below "Seconds."

Flavor - must be good, sweet, and fresh if of current make, and good and sweet, if held.

Body - must be good and reasonably uniform.

Color - reasonably uniform, neither very high nor very light.

Salt - may be reasonably high, light, or medium.

Package - Good and uniform.

"12. Seconds - Shall be a grade just below "Firsts".

Flavor - must be reasonably good.

Body - if creamery, must be solid boring. If factory or process, must be 90% solid boring.

Color - fairly uniform, but may not be mottled.

Salt - may be high, medium, or light.

Package - good.

"13. Thirds - Shall be a grade below "Seconds" and may consist of promiscuous lots.

Flavor - may be off flavored and strong on tops and sides.

Body - not required to draw a full trier.

Color - may be irregular or mottled.

Salt - high, light or irregular.

Package - any kind of package mentioned at time of sale.

"14. Packing Stock - Shall be sweet and sound, packed in large, new, or good uniform second hand barrels, having a wooden head in each end, or in new tubs, either to be parchment paper lined. Barrels and tubs to be packed full.

"15. No. 2. Packing Stock - Shall be reasonably sweet and sound, and may be packed in promiscuous or different kinds of barrels, tubs, tierces, without being parchment paper lined, and may be packed in either two-headed or cloth covered barrels.

"16. No. 3. Packing Stock - Shall be a grade below No. 2. and may be off-flavored or strong; may be packed in any kind or kinds of packages.

"Scoring as Affecting Grades of Creamery Butter.

"17. In the inspection of creamery butter for grade, the point system of scoring shall be used on the following basis:

Flavor, for perfection, . . . . .	45
Body, " " . . . . .	25
Color, " " . . . . .	15
Salt, " " . . . . .	10
Style, " " . . . . .	5
-----	
Total, for perfection, . . . . .	100

DAIRY BUTTER.

Its Position in the Market Classification.

From the foregoing market classification and definitions we find that "dairy" or farm butter must largely comprise those classed as process, factory, packing stock, and grease butter. It is safe to assume that very little if any creamery butter finds its way to the renovating plants to be made into process butter. The source of supply, for such plants, is the poorer grades of butter manufactured on farms and reaches the renovating plant through the country grocery stores and those of small cities. The butter in passing through the hands of grocers is "culled" or graded. The better butter is used in supplying a local retail trade while the poorer grades are classed as "packing stock" and shipped to renovating plants.

Dairy butter is also the chief source of supply for "factory butter". Many large grocery stores receiving dairy butter in lots varying in both quality and color resort to grading, salting, reworking, and in some cases coloring slightly then packing neatly and retailing or shipping to a general market.

For reasons perviously mentioned, practically all packing stock is the poorer grades of dairy butter, the relative importance of which is shown by the following table:

RELATIVE AMOUNT OF DAIRY BUTTER.

The Relative Amount of Dairy Butter as Compared with Creamery, Process, and Oleomargarine.\*

Year.	Dairy Butter.	Creamery Butter.	Process Butter.	Oleomargarine.
1860	459,681,372	---	---	---
1870	514,092,683	---	---	---
1880	777,250,287	29,421,784	---	---

Year.	Dairy Butter.	Creamery Butter.	Process Butter.	Oleomargarine.
1890	1,024,223,468	181,284,916	---	---
1900	1,071,745,127	420,954,016	---	107,045,028
1901	---	---	---	104,943,856
1902	---	---	---	126,316,427
1903	---	---	54,658,790	73,284,096
1904	---	531,480,000	54,171,183	50,199,642
1905	---	---	60,029,421	51,987,336
1906	---	---	53,549,900	55,434,900
1907	---	---	62,965,613	71,366,775
1908	---	---	50,658,158	81,525,600
1909	---	---	47,432,276	92,282,815
1910	---	725,000,000 (est.)	46,914,494	139,755,426

(\*) The statistics are taken from Bulletin No. 55, Bureau of Animal Industry and from the Revenue Commissioner's Reports.

From this table of statistics it is evident that the quantity of dairy butter manufactured in the United States is greater than either creamery or process butter. While the latest census available (1900) shows that the quantity of dairy butter was greatly in excess of creamery butter at that time it is the opinion of those who are closely in touch with output of creamery butter, and others familiar through renovating plants with dairy butter, that the latter is decreasing and that the output of creamery now exceeds that of the dairy.

#### The Quality of Dairy Butter.

The quality of dairy butter when compared with that of creamery is found to be much more variable. There are two principal reasons for this, first, there is greater incentive for producing a good grade of butter in a creamery, second, there is a better knowledge of the factors affecting the quality of the butter and, in addition, creameries are more suitably equipped for its manufacture.

The farmer who makes butter only for home use is not as careful of details as the man who is devoting all his time to that particular form of employment in a creamery. Inasmuch as this is the case we find that

the result is, a more uniform grade of butter is made in the creamery from day to day and in such quantities that an improvement in quality with a consequent increase in price is a greater incentive than an improvement on a few pounds would be. The ease with which conditions can be controlled and regulated at the creamery is greater than at the farms, due to the use of better and more convenient equipment such as pasteurizers, ripening vats, power churns and workers. The equipment necessary is comparatively cheaper because larger quantities of butter are manufactured and the relative cost between equipment and the value of output is reduced.

#### General Causes for Poor Quality.

The general causes for the poor quality of dairy butter are three:

1. The lack in many cases of cleanly conditions and practices.
2. The failure to control the temperature of milk and cream during the time it is held before churning.
3. The frequency of churning, careless practice of over-churning, and inaccurate method of salting.

The lack of cleanly conditions is a fundamental cause of trouble and prepares the way for future flavors and difficulties that no amount of care can eliminate, for it is under such environment that bacteria find conditions favoring their addition to milk. Dust, trash, or filth in any form is known to carry an enormous number of bacteria. When these are present in milk, which is recognized by bacteriologists as being one of the best media for bacterial development, it is sure to undergo a change, the effect of which depends almost entirely upon the nature of the organism growing in it. The breaking down of the milk constituents by the demands and action of the growing organisms results in flavors that are very pronounced in the milk products. Upon this bacterial action depends

the flavor of butter and it should be the desire of the buttermaker to allow this action or cream ripening to proceed only to the extent of producing the desired flavor and aroma. With this in mind it is well to endeavor, so far as practical, to keep out those objectionable organisms. The exclusion of filth is the first requisite and can be done only by cleanly conditions and practices.

The second cause of poor quality is that of temperature. Since the life and activity of any organism is dependent upon temperature, moisture, and food it is well to bear in mind those factors when considering the bacterial action upon milk. It is impractical to exclude all bacteria, in fact, under the most cleanly conditions, large numbers are sure to get into milk, but it is easily possible to prevent the addition of those which are most objectionable and are found associated with filth of all kinds. Milk, we have mentioned, is an ideal food for bacteria. Moisture is present. The other factor which affects <sup>their</sup> growth and activity is one which can be easily controlled, therefore, it is well to look closely to the temperature at which milk is held after being drawn from the cow. It has been found as a result of experimental work that bacteria act but slowly at temperatures of 50 degrees F. or below, while at 70 degrees F. or above they work rapidly and are capable of causing marked changes in a comparatively short time. Milk should, therefore, be cooled as soon after being drawn as possible. The failure to do this is probably the greatest cause of poor quality in dairy butter. The temperatures usually remain for hours, after milk is drawn and separated, within limits that most favor the rapid development of the organisms. The most common practice is to set milk and cream while warm in a room having a temperature of 60 -65 degrees F. This temperature while lowering that of cream or milk does it so slowly that many hours are afforded the busy bacteria in which damage can be done.

The caution, then is, keep the premises, and body of the cow as clean as practical and cool the milk or cream as soon as possible after it is drawn.

The third cause of poor quality in dairy butter is the frequency of churning but its importance is dependent almost entirely upon the temperature. The practice of churning only once in seven days or in some cases once in two weeks assures a doubtful quality of butter, but unless the temperature at which cream is held is low the poor quality is sure to be very pronounced. The only safe-guard in case the temperature is neglected is to churn frequently. This is, however, impractical because many dairy farmers do not get enough cream to justify more than one churning per week. If such conditions do render frequent churning impractical the alternative should be low temperatures. This low temperature is necessary, largely on account of the method or practice of collecting cream from day to day and adding it to that of preceding days. If, under such methods, cream is not kept at low temperatures the first lot soon becomes old and off-flavored and flavors all subsequent additions, usually resulting in an old strong-flavored butter at time of churning.

It was often found, in an investigation of the subject, that no efforts were made to get and maintain this low temperature. The larger portion of farmers set cream immediately after separation, in a room having temperature of between 60 and 70 degrees. The slowness with which this cream cools enables the bacteria to produce marked changes before their action is inhibited. The result being an old, off-flavored cream that yielded butter of same flavor. This old flavor could <sup>be</sup> and was in many cases "covered up" by the addition of high percentage salt but the high salt content, shown by later analyses, was more probably due to the careless inaccurate methods followed than to any intent or desire on the part of the maker, to "cover up" the old flavors. The greater percentage of farmers, it will be shown later resort

to rough estimation or guess in determining amount of salt needed. Uniformity under such methods is improbable.

#### Specific Causes for Poor Quality.

The specific causes for poor quality in dairy butter are numerous but can be easily classed under the general causes mentioned. The lack of cleanly conditions at stable, milk room, and place where cream or milk is stored is a common cause and source of contamination. The milk or cream may be contaminated as the result of filth being added or by the absorption of offensive odors and flavors. Dirty utensils always carry a host of bacteria, that later cause trouble, and usually possess an odor that is repulsive and ought not be about milk or its products. Cleanliness should be the dairyman's most constant motto.

The causes for poor quality dependent upon temperatures are principally those resulting from bacterial growth. The formation of by-products, as the result of breaking down of milk constituents, is the immediate cause of flavors and aromas and the longer those temperatures favoring this action exist the greater is the possibility and probability of a poor flavor developing.

The frequency of churning affects the action of bacteria in the production of flavors and aromas. It is well known that the principal food of milk bacteria is the milk-solids not fat so it is well to remove this fat from the solids not-fat by churning as soon as possible after the desired flavor is produced. This removal at once stops to a great extent, the bacterial action and produces a better quality of butter. It has been found by investigators, as a result of experimental work, that bacteria grow but slowly in butterfat, if at all, finally decrease, and eventually disappear. The presence of milk solids not fat in butter is not, therefore, desirable because of the food it furnishes for the growing organisms. The desirability



of removing this food for bacteria, which is in the form of buttermilk, makes apparent the necessity and advisability of washing butter thoroughly.

#### Possibility for Dairy Butter Manufacture.

The possibilities for dairy butter manufacture are almost unlimited. There are few consumers who would not prefer a good, high-grade, dairy butter to a creamery butter if it were not for the fact that practically all dairy butters vary widely and are very likely to be poor. It is claimed that as good or better grade of butter can be made from a sweet cream if it is taken, properly ripened, and churned, than if cream was handled carelessly, allowed to over-ripen, and become subject to other unfavorable conditions, as is often the case in gathered-cream creameries.

From the foregoing table of statistics, concerning relative amounts of dairy, creamery, and process butter as well as oleomargarine it is apparent that the amount of each has increased from year to year. This increase has probably been greater in the case of creamery butter than that of dairy.

#### The Position of Creamery and Its Relation to the Farmer.

This change from dairy butter -- manufacture, to sale of cream to creameries, is in most cases of benefit and profit to the farmers. The advantages given by most farmers would come under the following:

1. A reduction of labor which would necessarily be required for the manufacture of butter and sale of same,
2. The convenience in having a constant ready market for all butterfat in form of cream,
3. The price realized or received for butterfat is somewhere near that of high grade butter and is often more than the farmer, without a special market, obtains.

4. The labor saving and convenience are often more valuable to a farmer, having other duties, than the few cents he might realize in an advance in price on his ordinarily small amount of butter. If the farmer could and would go into butter-manufacture on a larger scale a few cents profit per pound would prove an alluring goal but with conditions as now it seems that the creamery is destined to supplant to a greater extent dairy butter manufacture.

The disadvantages for the farmer in patronizing a creamery were reported as follows:

1. The removal from farm of certain amount of nutrients both from the standpoint of feeding young stock and supplying plant food.
2. Many farmers are so isolated as to be unable to send cream often enough to insure good quality.
3. Distance from creamery in some cases is such that the time required in hauling is prohibitive to farmer, this is, however, largely overcome by the common practice among creamery men of gathering cream along established routes with own wagons, teams and drivers.

#### The Present Tendency in Dairy Butter Manufacture.

The present tendency in the manufacture of dairy butter is to decrease. This is largely due to the position held by the creameries, which not only in many cases makes it more convenient for the farmer to sell his cream, but proves more profitable as a result of the saving in labor and of furnishing a permanent market. Creameries are better able to maintain a uniform quality in butter than are dairies and, as a result of supplying a regular market, are able to realize a profit beyond what the individual farmers would be able to do. This in turn enables them to offer farmer prices for his cream or butterfat that are as profitable or more so than the manufacture of butter at the farm.

The convenience, saving of labor, and assurance of a regular market makes the creamery desirable for farmers, and so long as creamery butter sells at a higher price than dairy butter it is possible for the price of butterfat to closely approximate that of the butter itself. The net returns to creamery would be greater than to the individual farmers in case butter was manufactured at the farms. If farmers receive a "square deal" at hands of creamery men it is possible for creamery to prove profitable to both farmer and operator. It has been found<sup>(\*)</sup> that the average cost of manufacture of butter in creameries making 75,000 pounds per year, or approximately 250 pounds per day, is 2.78 cents per pound, but in creameries making 150,000 pounds per year, or approximately 500 pounds per day, the cost is only 1.78 cents per pound. There is no data at present which will enable an estimate of the average cost per pound of butter on the farm. This, however, is probably considerably above the cost in creameries where equipment is such that 250 pounds or 500 pounds can be made in less time than is required to manufacture 5 to 25 pounds on the farm. Economically it seems that creameries have come to stay.

#### Previous Investigations.

The previous investigation of manufacture of butter on farms of the United States is limited, so far as the writer has been able to find, to a study in New Hampshire(\*\*). No report of work nor reference has been found in the literature concerning dairy industry of European countries, that would indicate that such an investigation had ever been undertaken or reported. All mention of butter indicates that in most of those dairy countries the butter made at the farm is small or unimportant.

(\*) *Chicago Dairy Produce* - Dec. 17, 1907  
*New York Produce* - Dec. 11, 1907

(\*\*) *New Hampshire Bulletin* 141.

The larger part of butter is made in creameries - either cooperative or proprietary. The literature concerning farm butter manufacture has been confined almost entirely to efforts of instruction, and have not shown what the conditions, methods, and facilities for butter improvement were. Many good papers and bulletins have been written on the subject but are largely circulars of instructions and are often of such detail that it is difficult to decide which are the essential and necessary points to be emphasized. The result is, the greater part, or all, is neglected by the farmer who reads them for the first time.

#### The Investigation of "Dairy" or Farm Buttermaking.

##### Purpose.

The object of this investigation as previously stated was to obtain more definite and exact information, concerning dairy butter, that shall serve as a basis for future investigations.

##### Methods.

The methods followed in the collection of this data are probably open to criticism. There were certain difficulties in getting the information that would be hard to overcome. First it was difficult to determine what sections were typical dairy butter centers. Secondly, much of the information was given more or less reluctantly and may not be entirely accurate.

##### Sources of Information.

It was first necessary to learn, if possible, from state dairy commissioners, officials in dairy colleges, grocers, dairymen, and farmers what sections were known to produce or manufacture butter at the farm. After ascertaining the section where butter was made it was then possible to learn from grocers, and others what farmers were making butter.

Visits were then made to those farms, conditions were observed, and inquiries made concerning methods followed.

#### Conditions, Methods and Practices Studied.

The conditions studied or observed included the location of dairy barn, arrangement for convenience, cleanliness of surroundings and especially of stables where most farmers do their milking. The facilities or equipment for the manufacture of butter at the farms were observed, and included the methods of controlling temperature of milk and cream. These methods included the use of cold-boxes, cellars, spring-houses, running water, and iced-water. The equipment for the manufacture of butter both during churning and working was observed.

Inquiries were made concerning the ripening of cream, the frequency of churning, the degree of churning, amount of washing, method of salting, amount of working, the form of package used, the place of disposal of butter and price received. These facts, as gathered from each farm visited, are summarized in the following tables and serve as a basis for future investigations.

In addition to the information obtained, as mentioned above, a sample of the dairy butter was obtained and, later, studied analytically. As soon as these samples were collected at the farms they were put in glass jars and sealed in such manner that no loss took place through leakage or evaporation. They were then shipped to Chicago and immediately put in cold rooms held at a temperature of  $-10$  degrees C. Later in the year these samples were taken from storage and shipped to Washington where the analyses were made. The analyses consisted in the determination of moisture, salt, protein and butterfat.

GENERAL SUMMARY OF DATA CONCERNING  
METHODS AND PRACTICES ON DAIRY FARMS VISITED.  
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The following table shows points that were observed at the various farms visited and serves as a basis from which the shorter tables that follow are compiled. These shorter tables are a further summary, and enable the practices concerning each step in the manufacture of butter at the farm to be clearly set forth and suggest where methods and practices could be improved and how a better grade of butter made.









FURTHER SUMMARIES.

The preceding table showing a summary of conditions, methods, and facilities on farms visited is further summarized. The tables deduced from it are shown in the following pages.

Table No. 1. Showing number of days cream stands before churned.

State	P e r c e n t a g e h e l d .				Farms
	1 day	2 days	3-4 days	7 days	
Iowa	0	11.36	63.63	25.00	44
Michigan	0	30.61	57.14	12.24	49
Louisiana	20.00	70.00	10.00	0	10
Texas	85.71	14.29	0	0	7
S. Carolina	53.84	46.16	0	0	13
N. Carolina	0	0	100.00	0	2
Vermont	0	11.76	35.29	52.94	17
Total	10.64	25.53	45.25	18.44	142

From the above table it will be observed that the frequency of churning in the different sections varies. In the middle and northern states the greater percentage churn two or three times per week while in the southern states the larger percentage churn from three to seven times per week.

Table No. II. Showing Number of Times Churning is Done Per Week.

State	P e r c e n t a g e .				No. of Farms.
	Once	Twice	Three	Seven	
Iowa	27.66	63.83	8.51	0	47
Michigan	10.52	63.16	26.31	0	57
Louisiana	0	11.11	66.66	22.23	9
Texas	0	0	14.28	85.72	7
S. Carolina	0	7.68	38.46	53.84	13
N. Carolina	0	100.00	0	0	2
Vermont	50.00	44.44	5.56	0	18
Total	18.30	50.98	20.91	9.80	153

This table it will be noted checks closely the results in table No. I but the slight variation is due to the failure to get as full information from some farms as others.. It will be observed that the greater number of farmers visited churn twice per week. The percentage being as follows: 18.30% churn once per week, 50.98% churn twice per week, 20.91% three times per week, 9.80% seven times per week.

The extent or degree of churning is recognized as affecting the quality of butter. The following table shows the common practice in regard to amount of churning.

Table No. III. Showing the Extent or Degree of Churning.

State	Percentage Churned to			No. of Farms
	Granules	Small Lumps	One Mass	
Iowa	26.15	11.62	66.15	65
Michigan	18.18	13.63	68.18	66
Louisiana	45.45	9.09	45.45	11
Texas	50.00	37.50	12.50	8
S. Carolina	60.00	0	40.00	15
N. Carolina	20.00	0	80.00	5
Vermont	54.54	22.72	22.72	22
Total	31.25	11.98	56.77	192

It will be seen that more than 68% practice over-churning. This is a probable cause of rapid deterioration of butter, since washing in this form does not permit the buttermilk to be removed as efficiently as would be possible if butter was in granules when washed.

From the following table it will be seen that butter in most cases is washed a sufficient number of times but the physical condition of the butter is such that no amount of washing can remove the buttermilk enclosed by the butter.

Table No.IV. Showing Amount of Washing Butter Receives.

State	Percentage Washed.					No. of Farms
	None	Once	Twice	Three	Four	
Iowa	13.23	39.69	35.29	10.29	1.47	69
Michigan	5.41	29.73	47.29	16.21	1.35	74
Louisiana	11.76	23.52	23.53	23.23	18.23	17
Texas	14.28	71.44	14.28	0	0	7
S.Carolina	0	60.00	20.00	20.00	0	15
N.Carolina,	0	25.00	37.50	25.00	12.50	8
Vermont	0	28.57	61.90	9.52	0	21
Total	7.62	35.71	39.52	14.29	2.86	2,10

From the foregoing table it will be seen that 35.71% wash butter once; 39.52% wash twice and 14.29% wash as much as three times. The only conclusion in this case is that butter is put through sufficient water but is in such condition that the washing is not efficient. Besides making washing inefficient the massing of butter affects the ease with which salt may be evenly distributed and worked into it. The method of determining the amount of salt, however, as shown by the following table, is such as to make a uniform salt content improbable.

Table V. Showing the Method of Salting Butter.

State	Percentage Salted.			No. of Farms
	By measure	By weight	By guess	
Iowa	6.06	0	93.94	66
Michigan	1.49	8.95	89.55	67
Louisiana	0	0	100.00	11
Texas	0	0	100.00	14
S. Carolina	0	4.16	95.84	24
N. Carolina	0	20.00	80.00	5
Vermont	0	79.17	20.83	24
Total	2.37	12.79	84.83	211

From the above table it will be seen that almost 85% of the farmers simply guess at the amount of salt to be added to butter, but in Vermont, where the manufacture of dairy butter is probably more advanced or more generally followed, the most common practice is to weigh both the salt and butter. In this way a more uniform<sup>ly</sup> salted butter is obtained. The method of distributing the salt or "working" the butter is shown in table VI.

Table No. VI. Showing Means by Which Working is Done.

State	Percentage Worked with			No. of Farms
	Hands	Paddles	Workers	
Iowa	4.44	95.56	0	45
Michigan	0	100.00	0	54
Louisiana	0	87.50	12.50	8
Texas	0	87.50	12.50	8
S. Carolina	7.14	78.57	14.28	14
N. Carolina	0	75.00	25.00	4
Vermont	0	0	100.00	19
Total	1.97	82.24	15.79	152

This table shows that the greater number of the farmers visited use hand paddles to work or knead the butter. This may have been the case, in those states other than Vermont, simply because the quantities of butter were small and farmers did not feel justified in having other forms of butter workers.

The markets for dairy butter are numerous but have been grouped under the two headings, "Special" and "General." The following table shows to what extent farmers find special markets and what the range in price is between the special and general.

Table VII. Showing Number of Farms Having Special and General Markets,  
and Difference in Price Received.

State	No. of Farms Having		Price of Specials				Price of Generals		
	Special	General	18-20	20-25	25-30	30-35	18-20	20-25	25-30
Iowa	10	18	0	0	7	3	5	13	0
Michigan	11	29	3	8	0	0	5	24	0
Louisiana	4	1	0	0	4	0	0	1	0
Texas	6	5	0	0	6	0	0	5	0
S. Carolina	5	1	0	0	5	0	0	1	0
N. Carolina	1	0	0	0	1	0	0	0	0
Vermont	9	7	0	0	3	5	0	0	7
<b>Total</b>	<b>46</b>	<b>61</b>	<b>3</b>	<b>8</b>	<b>26</b>	<b>8</b>	<b>10</b>	<b>44</b>	<b>7</b>
Per cent of total	43	57	6.52	17.39	56.52	17.39	16.39	72.13	11.47

In the following table is shown the wide variation in composition of farm butter and indicates one of the important causes for the low price received. Any product having such variation in both composition and flavor is sure to retain a market under great difficulties.



Table No. VIII Showing Variation in Composition of Farm Butter  
and Its General Average.

P e r c e n t a g e s o f			
W a t e r .	S a l t .	P r o t e i n	B u t t e r f a t
8.2 minimum	0.30 minimum	0.23 minimum	56.13 min.
42.9 maximum	18.30 maximum	0.92 maximum	89.65 max.
14.48 average	4.08 average	0.48 average	80.68 ave.
of which	of which	of which	
21.68% were above 16.00%	45.28% were above 4.00%	12.5% were above 0.70%	
31.32% were between 13-16%	11.32% were between 3 & 4%	27.5% were between 5 & 7%	
46.98% were below 13%	23.58% were between 2 & 3%	60.0% were less than 0.5%	
	20.75% were below 2%		

From the above it will be observed that the moisture varied between the limits of 8.2% as low and 42.9% high, while 21.68% of the samples analyzed showed moisture content above 16.00%, 31.32% of the samples were between 13 and 16% , and 46.98% below 13%.

The salt content varied between the limits 0.3% and 18.3%. Of the number analyzed 45.28% were above 4.00%, 11.32% were between 3% and 4%; 23.58% and between 2% and 3%; and 20.75% were below 2%.

The protein content varied between the limits of 0.23% and 0.92%. Of the number analyzed 12.5% were above 0.70%; 27.5% were between 0.5 and 0.7% and 60.0% contained less than 0.5% protein.

The butterfat content varied between the limits of 56.13% and 89.65%.

The high moisture content in some cases may have been due to overchurning at high temperatures. The butter being so soft that washing or working could not be successfully accomplished. Table No. 3, shows clearly that greater portion of dairy butter is overchurned and makes washing difficult. High temperatures leave butter too soft to be worked.

The salt variation, it is safe to say, was due to the inaccurate and careless methods used in determining the amount that was to be added.

The variation in protein content was less than anticipated. Since butter was in many cases from overripened, curdled cream, was overchurned, and buttermilk not thoroughly removed it would be expected to find a variation in protein content. This was not borne out by an examination of the samples. Theoretically the unwashed butter should contain more protein than that which was washed. The comparison was made in several cases but results did not show such to be the case.

The butterfat in the dairy butter analyzed was found by difference, that is, the sum total of moisture, salt, and protein was deducted from 100%. This difference was considered as butterfat. This, while not absolutely true, is so slight that the error can be overlooked. The milk sugar in butter is by this method, of course, considered butterfat.

## DISCUSSION OF DATA AND RESULTS.

### Cleanliness.

In the investigation or study it was endeavored to get a general idea concerning all phases of dairying which had a bearing upon manufacture of butter at the farm, beginning with the cleanly condition of the cows. During that portion of the year in which the study was made the bodies of the cows were clean, due to the fact that in practically every case they were allowed to run at will in pastures. Many of the barns and stables were examined and found to be of such character that milking in them was sure to result in contamination of the milk by the introduction of trash, <sup>and</sup> filth, and absorption of stable odors. It was very seldom that a light well ventilated barn was found among those farmers who were making butter, and it was also observed that the greater number of large dairy farmers were selling milk and cream, as such, to creameries, condenseries, milk consumers, and cheese factories. It was only the small farmers, especially through the middle west and northern states, who were making butter. This was largely on account of the small quantity of cream or milk and the inconvenience in transporting cream or milk to creameries.

The milkers were in most cases comparatively cleanly but in no case werewhite dairy suits in use. Some practiced milking with wet hands. The utensils, like buckets, separator, etc., were not washed and sterilized as well as might be wished for. These necessarily carried an enormous number of bacteria into the milk.

### Control of Temperatures.

The methods of handling or ripening cream were in most cases very poor. From Table No. I it will be seen to what extent cream is held before churning. From 141 farms visited 10.64% held cream only one day before churning;

25.53% held cream two days; 45.25% held cream three to four days, and 18.44% held cream seven days. The temperature at which this cream was held varied from 55 degrees to 75 degrees and in one or two instances showed a temperature of 80 degrees. The places utilized for holding cream varied. Iced-boxes, cellars, cold running water, cold standing water, ordinary living rooms, pantries in warm kitchens, and even shade trees in the open, were in use as places for maintaining low temperatures. While it was apparent that an effort was made to put cream and milk in coolest places, a lack of suitable equipment for the proper care of cream was found. The water from wells and springs was found in almost every case to range between 48 degrees and 60 degrees, in most cases being near 52 degrees. This suggests the possibility of utilizing, in some convenient inexpensive, yet practical way, water from wells as a cooling media for milk and cream.

The following table shows the effect and possibility of cold water as a cooling media, as compared with atmosphere.

General Average Cooling of Each Method.

Method	Cooling media, Temp. of	Temperature of cream.	Temperature at later periods.								
			½hr.	1hr.	2hrs.	3hrs.	4hrs.	5hrs.	6hrs.	7hrs.	8hrs.
1	52	86.5	83.8	75.6	65.1	62.5	60.5	59.0	58.0	57.0	56.1
2	52	85.5	77.0	68.4	63.5	60.5	58.7	57.5	56.4	55.5	55.0
3	52	89.0	86.7	83.0	76.7	73.0	70.0	68.2	67.0	65.7	65.0
4	62	92.5	90.5	89.0	87.0	85.0	82.0	80.5	79.0	78.0	76.5

In method (No. 1) the cream was put in a "shot-gun" can (8½ inches in diameter and 19 inches deep) and allowed to set in cold running water without

being stirred, for eight hours. No further change was noted although it is possible that there was a slight lowering of temperature even after that time.

In method (No.2) cream was put in a similar can, was set in vat filled with cold running water and was stirred at intervals of one-half hour.

In method (No.3) cream was in similar can but was set in cold non-running water and was not stirred.

In method (No.4) cream was in same kind of milk can and was allowed to set on floor of creamery room, which was a cellar with granitoid floor, having a temperature of 62 degrees.

In method (No.1) the result is an average of five trials. Method (NO. 2) is average of four trials, Method(No.3) is average of two trials, while method (No.4) is only one trial.

Now, if bacteria grow more rapidly in milk where the temperatures are between 70 degrees and 90 degrees, the efficiency of the various methods of cooling, in inhibiting this growth, becomes interesting. In the case of cream set in running water it will be observed that the temperature was reduced to 70 degrees or below in less than two hours, while in the non-running water it required four hours. In that held at room temperature it was cooled to 82 degrees at end of four hours and had reached only a temperature of 76.5 degrees at the end of 12 hours. This shows how slowly the temperature of a cellar or room having a temperature of about 60 degrees lowers the temperature of milk or cream placed in it. It also shows how much more effective water is as a cooling media. When we recall that the larger number of farmers visited made use of the cellar for cooling and that cream was held from three to seven days it is reasonable to expect to find a comparatively poor butter.

### The Method of Collecting Cream on Farms for Churning.

The method of collecting cream for churning was practically the same at all farms visited. In each case the cream was saved from day to day and added to that of the preceding days. This practice was continued until sufficient was obtained to justify a churning or until it was convenient to churn. The quantity of cream obtained daily varied from one pint to two or three gallons. In some cases, particularly those in which the larger quantities were obtained, cream was cooled by setting in iced-boxes, cellars, or cold water before addition to that of preceding days. In a few cases a buttermilk starter was added to cream during the winter months but not during the summer. The only advantage claimed was that addition of starter hastened the ripening and caused cream to churn more readily and efficiently.

### Kind of Churns Used.

The kind of churns used on farms varied greatly. Those most commonly used were, the stone jar with a perpendicular dasher, box churns with inside fixtures which were agitated or operated by means of a crank, barrel churns without inside fixtures and swing churns without inside fixtures. In these latter types the cream is churned by falling upon itself during the revolution and swinging of the churns.

### Power for Operating Machinery.

The power for operating churns and other machinery about the dairy differed. Many farmers operated all machinery by hand, others used treadmills, operated by a horse, bull, sheep or dogs. Steam and gasoline engines, and electric motors were used in the New England states. The majority of farmers visited, however, were using hand power for operation of separator, churn, and butter workers.

### The Extent or Degree of Churning.

The extent or degree of churning is generally thought to have an important relation to the keeping quality of butter. The influence is apparent in this way. When butter is over-churned it is massed in the presence of buttermilk and incorporates a large quantity in the irregular cavities and is not easily removed by washing. Since bacteria require for growth milk constituents other than butterfat it is possible to limit their development and thus check their deteriorating influence on butter by a complete removal of buttermilk as a result of thorough washing. This can best be accomplished if the churning is stopped while butter is in granular form. Most of the buttermilk can be drawn off directly and the remainder removed by washing with cold water. A study of Table No. III will show that the greater number of farmers churn butter to such extent that thorough washing is impossible. This table it will be noticed shows that 31.25% churn to granules, 11.98% to small lumps and 56.77% to one mass, or about 68% practice over-churning.

### Washing of Butter.

The amount of washing butter receives on farms varies widely. The cause for this is the different beliefs concerning the desirability of washing butter. There are a number of large dairy buttermakers who maintain that washing butter is detrimental. This belief is based upon the fact that in many cases butter is made from a fine flavored cream and is consumed within three to four days after made, or in some cases, in even less time. The claim under such conditions is that the desirable flavor is greatly reduced by the total removal of buttermilk and leaves the butter with a flat insipid taste. This is probably true in some cases but it is safe to say that in the majority of cases the fine flavored cream is displaced by cream having flavors

that are less desirable. Other makers wash butter from one to four times in an endeavor to remove all buttermilk from butter that has been overchurned. When such is the case it is necessary to work through the butter while it is in the water. The test for sufficient washing is the cloudiness of wash water when drawn off. The object in most cases is to continue washing until the water "comes off" clear. By recalling the extent of churning, as shown in Table No. III it can be inferred that much of the buttermilk, originally in the butter, is not removed by washing. The amount of washing butter receives is shown in Table IV. From this table it is observed that of 210 farmers visited, 7.62% do not wash butter, 35.71% wash only once, 39.52% wash twice, 14.29% wash three times, and 2.86% wash four times. While it is apparent that butter in most cases, is washed sufficiently, still the quality is poor due to the fact that the cream from which it was made was old and off-flavored when churned. This old flavor was the result of the method of collection and practice of holding cream at temperatures which favor a rapid growth of bacteria.

#### Salting of Butter.

The method of salting varies. The practices are such that uniform salt content cannot be maintained. There are three methods that are most commonly followed; (1), that of a rough estimation or guess by which salt was added until considered sufficient; (2), that by which the amount of butter was estimated by a mental comparison with other and previous lots and the salt measured in cups or other vessels; (3), that in which butter was weighed and for each pound of unworked butter one-half to one and one-half ounces of salt were weighed and added. This latter method insured a more uniform salt content than either of the other methods. A very common practice with many farmers was to work butter slightly before the addition of salt. This slight



working removed most of the moisture. When salt was added and butter worked the salt remained undissolved due to lack of sufficient moisture. Such butter was gritty even after months of storage. This practice, in cases where both butter and salt were weighed, usually gave a very high but uniform salt content. Usually one ounce of salt to one pound of butter was added thus making six per cent of salt possible. Analyses of such butter for salt almost invariably showed from 4 per cent to 6 per cent. As a result of this high salting and a high moisture content several farmers were getting as *much as* twenty-nine per cent overrun.

From Table No.V it will be observed to what extent salting is done by rough estimation or guess. This table shows that of 211 farmers visited, 2.37% reported that amount of butter was estimated and amount of salt measured; 12.79% weighed both butter and salt while the remaining 84.83% used rough estimations or guess as to both quantity of butter and salt. In addition to undesirable methods of salting butter it was found that many farmers were using a very poor coarse grade of salt.

#### Working of Butter.

Working of butter has for its object an even distribution of salt, the production of a fine grain texture, and firm waxy body. The equipment used in working butter varies with individuals as does also the amount of working. Some use only the bare hands, some wooden paddles or ladles and others use some form of mechanical workers. The amount of working butter can undergo without injury to body or texture depends almost entirely upon the firmness of the butter. This of course is determined by the temperature at which cream is held before and during churning. The desirable temperature varies with the season of the year, the food, the time in lactation, breed of cows and even with individual cows of the same breed. It has generally been found that this temperature ranges near 50 to 55 degrees in summer and

55 to 65 degrees in winter. The only definite way however of determining the most satisfactory temperature is by experiment. The result desired is a firm bodied butter that has required from 25 to 35 minutes for churning. When butter is in such condition it is more thoroughly washed, can be more satisfactorily worked without fear of injury to grain or body and is more easily handled.

Table No.VI shows the most common equipment and means of working butter and the practice most common in the various states. It will be noted that of 152 farms visited 1.97% reported that butter was worked with the bare hands, 82.24% used paddles; while 15.79% used some form of mechanical worker, which is recognized as the most satisfactory means of working butter and distributing the salt. Many farmers producing small quantities of butter consider the cost of mechanical workers as prohibitive.

#### The Form of Packages for Dairy Butter.

The form of package used by dairy farmers for butter varies, but in the case of the smaller farmers no package of any kind is used. Butter is usually put up in rolls and wrapped with a thin light cloth or it may simply be packed in a small dish, crock or other similar vessel, covered with a moistened cloth and delivered to the purchaser. On the larger dairy farms, however, where butter is made and a private trade supplied, the butter is put up in uniform rolls or prints and wrapped with parchment paper and, in some cases, enclosed in cartons. This practice of putting butter in prints is very generally followed throughout New England, but in the middle states the use of dishes and crocks is much more common. Where prints are used they most generally have some design that give the print of butter a distinctive mark that enables the purchaser to know whether he is getting the butter asked for. In other cases the plain print is wrapped in parchment paper having the name

of the farmer printed upon it. Either of these not only makes the butter more attractive but serves as an advertisement that proves profitable. This profit may be measured in dollars or in giving the maker cause for pride in his product.

#### Marketing of Dairy Butter.

The marketing of dairy butter is a subject which demands attention. The profit to the farmer depends upon his ability to successfully find and retain a suitable market. The success of the New England farmers in finding suitable markets for their produce is worthy of consideration. On account of their proximity to city markets their method of disposing of their dairy produce is optional - that is, the milk or cream may be sold as such for immediate consumption or it may be made into butter and sold in that form. If it is made into butter three or four markets are available; It may be sold (1) to private customers, hotels, or restaurants; (2) to general grocery stores, (3) to commission houses in the larger cities, or (4) it may even be sold to creameries. The principal cause of their success, however, is good quality of butter and constant effort to give their customers fair treatment.

A study of Table VII shows the relative number of farmers who have special and general markets. Those reporting a special or private market, it will be observed, received prices which were slightly above those reporting a general market at stores. Of 107 farmers reporting sale of butter 46 or 43% were supplying special markets while 61 or 57% were selling their butter to stores. The conclusion that this data, if any is permissible and justified, is that the special prices on the whole range about five cents per pound above those of general market, that is, the greater per cent of each class is as follows: 56.52% of those supplying a special market were receiving between 25 and 30 cents per pound while 72.13% of those supplying a general market were receiving between 20 and 25 cents per pound.

Composition of Dairy Butter.

The great lack of uniformity in dairy butter makes it almost impossible to supply an exacting market. This lack of uniformity as stated in the preceding pages is due to several causes. The most common ones are as follows: (1) Lack of cleanly conditions at the barn and milk room coupled with use of milk pails which are not sterile and often not clean; (2) The failure to control the temperature at which cream is held previous to churning, resulting in overripening and off-flavor; (3) The practice of over-churning and inefficient washing; (4) Inaccurate methods of salting and over-working. From analyses of butter samples collected at the farms visited, the variation in composition was found to be as great or greater than the variation in flavor, color, and body. From the following table (No.VIII) the percentage composition and wide variation is apparent.

	Moisture.	Salt.	Protein.	Butterfat.
Minimum	8.2%	0.30%	0.23%	56.13%
Maximum	42.9	18.30	0.92	89.65
-----	-----	-----	-----	-----
Average	14.48	4.08	0.48	80.68

Of the samples analyzed for moisture 21.68% contained above 16% water; 31.32% contained between 13 and 16%; and 46.98% contained less than 13% moisture. Of those analyzed for salt 45.28% contained above 4% salt; 11.32% contained between 3 and 4%; 23.58% contained between 2 and 3%, while 20.75% contained below 2%. Of those analyzed for protein 12.5% contained above 0.70% protein; 27.5% contained between 0.50% and 0.70% ; and 60% contained less than 0.50% protein. The butterfat it will be observed varied from 56.13% to 89.65% with an average of 80.68%. This lack of uniformity is due largely

to the methods and practices followed in care of cream previous to churning and in the manufacture of the butter.

Summary of Data and Results.

The following tables briefly summarize the methods and practices in the states of Iowa and Michigan, and are suggestive of the principal causes of poor quality in dairy butter.

Table IX. Showing a Summary of Methods and Practices  
In State of Iowa.  
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Expressed in Percentages.

P e r c e n t a g e s .						
Percentage	1 day	2 days.	3 days	7 days	No. of farms	
Ripened	0	11.36	63.63	25.00	44	
Percentage	once	twice	three	seven		
Churnings per week	27.66	63.83	8.51	0	47	
Percentage	granules	small lumps	one mass			
Churning to	26.15	11.62	66.15			65
Percentage	none	once	twice	three	four	
Washing	13.23	39.69	35.29	10.29	1.47	68
Percentage	measure	weight	guess			
Salting by	6.06	0	93.94			66
Percentage	hands	paddles	worker			
Working with	4.44	95.56	0			45
Kind of Markets	No. farms	No. farms	Special prices.		General prices.	
	Special	General	25-30¢	30-35¢	18-20¢	20-25¢
	10	18	7	3	5	13
Average Composition	Moisture		Salt		Protein	
	Av. 34 samples 16.35%		36 samples 2.44%		30 samples 0.493%	

The above table shows the common practices in Iowa to be such that improvement is possible. The greater percentage of farmers hold cream from 3 to 7 days before churning. This is sure, under the common methods of handling cream, to result in over-ripening. The over-churning of this ripened cream, the inefficient washing as a result of the over-churning, and the inaccurate, careless methods of determining amount of salt result in a product which is lacking in uniformity and is not suitable in most cases for an exacting market. The average composition, it will be observed, was: moisture 16.35%; salt 2.44% and protein 0.493%. The difference in price received by those supplying a special market and those supplying a general market was, as stated before, about five cents per pound.

Table X. Showing a Summary of Methods and Practices  
in State of Michigan.

Percentage	<i>Percentages</i>				No. of farms	
	1 day	2 days	3 days	7 days		
Ripened	0	30.61%	57.14%	12.24%	47	
Percentage Churning per week	once	twice	three	seven	57	
	10.52	63.16	26.31	0		
Percentage Churned to	granules	small lumps	one mass		66	
	18.18	13.63	16.21			
Percentage Washing	none	once	twice	three	four	74
	5.41	29.73	47.29	16.21	1.35	
Percentage Salting by	measure	weight	guess			67
	1.49	8.95	89.55			
Percentage Worked with	hands	paddles	worker			54
	0	100.00	0			
Kind of Markets	No. farms Special	No. farms General	Special prices		General prices	
	11	29	18-20¢	20-25¢	18-20¢	20-25¢
			3	8	5	24
Average composition of butter	Moisture (49 samples)		Salt (70 samples)		Protein (50 samples)	
	13.19%		5.18%		0.477%	

The practices and methods in Michigan as shown by the above table differ from those of Iowa. Two things are noticeable. (1) The special and general markets as reported in Michigan did not differ, and (2) the composition of the samples analyzed differs. In Iowa it will be noticed moisture was high and salt low, while in Michigan the salt was high and moisture low. The cause for this is uncertain.

Table XI. Summary of Methods Expressed in Percentages  
on all Farms Visited in Various States.

P e r c e n t a g e .						
Times ripened	Held 1 day 10.64	Held 2 days 25.53	Held 3-4 days 45.25	Held 7 days 18.44	No. Farms 141	
Number of times churning per week	once 18.30	twice 50.98	three 20.91	seven 9.80	153	
Extent of Churning	to granules 31.25	to sm.lumps 11.98	to one mass 56.77		192	
Amount of washing	none 7.62	once 35.71	twice 39.52	three 14.20	four 2.86	210
Methods of salting	by measure 2.37	by weight 12.79	by guess 84.83		211	
Method of working	with hands 1.97	with paddles 82.24	with worker 15.79		152	
Methods of marketing	Special 43	General 57			107	
Methods of cooling	with ice 2.83	with water 11.74	In cellar (no data) atmosphere 85.42		247	
Churn, equipment	barrel 50.25	crank-dash 13.71	dash 32.49	swing 3.55	197	
Composition of Dairy Butter	moisture 14.48	salt 4.08	protein 0.48	butterfat 80.68	Minimum Maximum Average	

The above tables (Nos. IX, X, & XI) show summaries concerning methods and practices on dairy farms visited in the states of Iowa, Michigan, Louisiana, Texas, North and South Carolina, and Vermont. The tables are in such form that very little explanation is necessary. The tables are divided, which summarize the practices and methods concerning each step in the manufacture of butter on farms, are separated by use of double lines. In the column to the right is given the number of farms visited and reporting concerning that particular step or practice in the manufacture



of butter. While this data is probably insufficient to warrant any very definite conclusions it shows what the range in variation is and will serve as a basis for further investigations.

#### CONCLUSIONS.

From the preceding work and pages the following conclusions are drawn.

1. The condition of cows during summer months is good, due to the common practice of allowing them to run at will in pastures, and examination of barns and milk sheds indicates that cleanly conditions do not exist during winter months when cows are housed.

2. The care of milk and cream previous to churning in many cases is poor as a result of high temperatures. Failure to reduce cream or milk to a temperature which inhibits bacterial action results in the production of objectionable flavors.

3. The practice of collecting small amounts of cream from day to day, along with the failure to maintain temperature low enough to check bacterial action, is usually the cause of old-flavored cream and butter.

4. Over-churning is widely practiced due in some cases, to the belief that incorporation of buttermilk is desirable, and in other cases, is a result of carelessness or ignorance. This practice prevents thorough washing and results in hastening the deterioration of the butter.

5. The amount of washing in the majority of cases is sufficient to remove all traces of buttermilk provided butter is not over-churned.

6. The percentage salt in dairy butter varies widely due to the methods used. The method followed is one of rough estimation or guess.

7. The working of butter is done largely by use of paddles or ladles due to the fact that quantities manufactured are small and the expense is slight.

8. Dairy butter is packed in various forms of packages or in none. It is disposed of in one of four ways. (1) Consumed at farmhouse; (2) Sold to

grocery stores or hucksters; (3) Sold to private customers, locally, or, in nearby cities, or (4) to wholesale commission houses in cities.

9. The methods of cooling cream vary, but four principal ones were followed: (1) cream or milk was allowed to set at atmospheric temperatures, (2) cooled by setting in cellars having a temperature of 60 to 75 degrees; (3) cooled by setting cream or milk cans in cold water kept so by (a) addition of ice, (b) by allowing fresh water to flow around cans, or (c) by drawing off the water which has become warm, and adding a fresh supply of cold water, and (4) cooled by placing cream or milk in iced-boxes or refrigerator.

10. The equipment used in the manufacture of butter varied but included practically all kinds of separators, ripening vats, churns and workers. The working was done in three ways: (a) by use of bare hands, (b) by use of wooden paddles or ladles and (c) by use of mechanical workers. The churns were of two general types: (a) those agitating cream by means of a dasher, which is operated either perpendicularly with the hands, or in rotatory manner by use of crank - the rotation being either horizontal or vertical, and (b) those without inside fixtures, the cream being agitated as a result of falling during the revolutions of the barrel churn, and swinging of the swing churn.

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