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# The Relation Between Age, Weight and Fat Production in Dairy Cows

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# The Relation Between Age, Weight and Fat Production in Dairy Cows

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Abstract.—Facts are here presented showing that the fat production of dairy cattle gradually increases up to an age averaging between seven and eight years and then gradually decreases. Conversion factors have been determined for cows of the Jersey, Guernsey, and Holstein breeds and this makes it possible to estimate the mature fat production for cows at various ages. It is also shown that after the Jersey cow reaches the body weight of 470 pounds, there is an average increase of 104 pounds in fat production per year for an increase of 100 pounds of body weight with age. Eighty per cent of this increased fat production, however, was found to be due to the development of milk secreting tissues and other changes of the body consequent to increase in age. Twenty per cent of the increased fat production was attributed directly to the increase in weight.

Milk secretion, like other physiological processes, changes with age in a definite way. It was observed at an early date that milk and fat production, on the average gradually increase as the dairy cow becomes mature and then gradually decrease with the onset of old age; thus under similar conditions of feeding and management a heifer is expected to increase her yearly production at each succeeding lactation period until she reaches maturity.

There has been, however, more or less uncertainty among breeders of dairy cattle as to the age of maturity and maximum production of milk and fat. The rate of increase of production with each succeeding year and lactation is also a debated question.

At the time of the adoption of the advanced registry system by the several dairy cattle breed associations, accurate data were not available and therefore arbitrary minimum requirements for entrance varying from 250.5 pounds of fat at two years to 360 pounds of fat at five years were established. While these requirements were arbitrary and not based on data, they have been widely accepted by dairymen as indicating that milk secretion increases with age up to a certain point and that maximum production is reached by the time the dairy cow is five years old.

Since the inauguration of the advanced registry system in this country many thousands of yearly and seven-day records have been completed and reported in the herd books of the several breed associations. The records furnish excellent data to determine the relation be-

tween age and milk secretion throughout the entire productive life of the dairy cow.

Pearl and co-workers[1] at the Maine Experiment Station made use

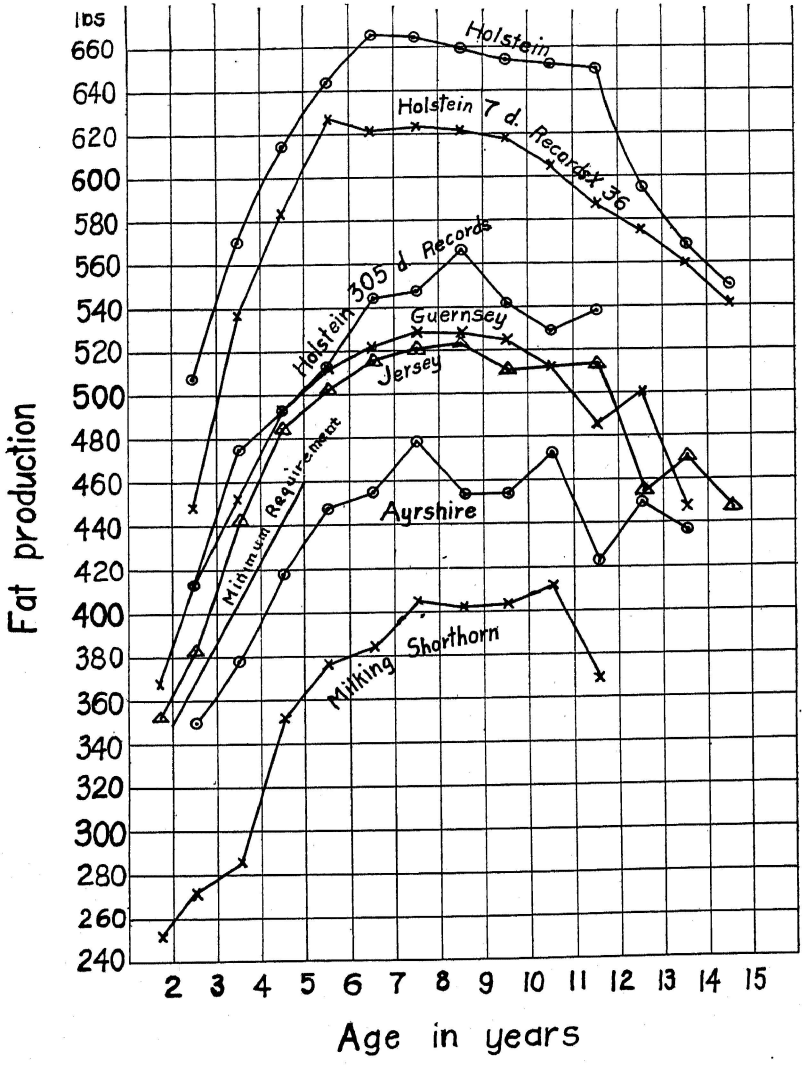


Fig. 1.—THE RELATION BETWEEN AGE AND FAT PRODUCTION IN DAIRY CATTLE. With the exceptions noted the curves represent the butterfat production on yearly test. The minimum requirements are raised 100 pounds for convenience of comparison.

[1]Pearl, R. and Patterson, S. W., Maine Agr. Exp. Station Bul. 262, 1917. Pearl, R. and Miner, J. R., Jour. Agr. Research, 1919, XVII, 285. Pearl, R., Gowen, J. W., and Miner, J. R., Ann. Rept. Maine Agr. Sta., 1919, 89. Gowen, J. W., Genetics, 1920, V, III. Gowen, J., Ann. Rept. Maine Agr. Exp. Sta., 1920, 185.

of a limited number of records in tracing the relation of milk flow to age in dairy cattle. Hooper[2] of the Kentucky Experiment Station and McCandish[3] of the Iowa Experiment Station have also presented a limited amount of data showing the relation between age and production.

Since the data presented by these workers were rather limited, the Missouri Experiment Station has considered it worth while to compile all the available data. With the cooperation of the advanced registry departments of the several breed associations, it has been possible to secure practically all the fat production records made in this country previous to the recent changes in the minimum requirements.

In making a study of these records, it was realized that the records are of a selected population. In the first place the minimum entrance requirements eliminate all animals incapable of meeting this standard. In the second place, the cows of advanced ages are also more or less selected, as only cows of exceptional ability as producers would be tested at advanced ages, and due to the declining productive ability as they grow old they enter the advanced registry with increasing difficulty. These considerations must be kept in mind in making use of this bulletin.

## THE RELATION BETWEEN AGE AND FAT PRODUCTION

In Table 1 are presented the results of a study of 46,002 yearly records and 104,583 seven-day records classified by age intervals of one year. As will be seen from Fig. 1 the age of maximum production varies but slightly between the several breeds, and the difference does not appear to be significant. It will be seen that fat production gradually increases up to between seven and eight years of age on the average, and then gradually decreases with the onset of old age. The minimum requirements are also plotted, being raised 100 pounds for convenience of comparison. It will be seen from the difference in the slope of the two curves that up to eight or nine years of age, the older the cow the easier it is for her to exceed the minimum requirements, but after that age animals are at a constantly increased handicap due to the effect of old age on production.

In Fig. 2 the weighted average production of all breeds on yearly test is plotted in terms of the percentage of the maximum production. By means of this chart one can easily determine what may be expected of a dairy cow at various ages in relation to her maximum production.

It is often of interest to convert records made at various ages to their mature equivalent for the purpose of comparison. Using the data showing the relation between age and production, conversion factors

[2]Hooper, J. J. Kentucky Agr. Sta. Bul. 234, 1921.
[3]McCandlish, A. C., Iowa Agr. Exp. Sta. Research Bul. 73, 1922.

## TABLE 1.—THE RELATION BETWEEN AGE AND FAT PRODUCTION OF DAIRY CATTLE

| Age years | Ayrshire cows | | Guernsey cows | | Holstein cows | | | | Jersey cows | | Milking Shorthorn cows | | Weighted average of all cows | | Fat expressed as per cent of maximum production | Seven-day records | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 365-day | | 305-day | | | | | | | | | | |
| | No. cows included | Fat per year | No. cows included | Fat per year | No. cows included | Fat per year | No. cows included | Fat per year | No. cows included | Fat per year | No. cows included | Fat per year | No. cows included | Fat per year | | No. cows included | Pounds of fat |
| | | *lbs.* | | *lbs.* | | *lbs.* | | *lbs.* | | *lbs.* | | *lbs.* | | *lbs.* | | | |
| 1.7 | * | | 313 | 368 | | | | | 947 | 353 | 15 | 252 | 1275 | 355.4 | 64.6 | | |
| 2.5 | 1710 | 350 | 5241 | 412 | 2454 | 508 | 1250 | 413 | 4090 | 383 | 306 | 272 | 15001 | 404.9 | 73.6 | 33765 | 12.46 |
| 3.5 | 903 | 378 | 2566 | 452 | 1523 | 570 | 762 | 475 | 2263 | 443 | 167 | 285 | 8184 | 462.0 | 84.0 | 22019 | 14.91 |
| 4.5 | 716 | 418 | 1977 | 492 | 1238 | 615 | 606 | 493 | 1687 | 486 | 125 | 352 | 6349 | 497.1 | 90.4 | 16374 | 16.20 |
| 5.5 | 545 | 448 | 1133 | 511 | 1116 | 644 | 467 | 513 | 1487 | 502 | 75 | 376 | 4823 | 424.7 | 95.5 | 11259 | 17.39 |
| 6.5 | 399 | 455 | 897 | 521 | 835 | 666 | 331 | 544 | 1067 | 516 | 80 | 383 | 3609 | 544.8 | 99.1 | 8356 | 17.26 |
| 7.5 | 298 | 478 | 527 | 528 | 583 | 665 | 223 | 547 | 837 | 521 | 66 | 405 | 2579 | 549.4 | 100.0 | 5586 | 17.32 |
| 8.5 | 225 | 453 | 369 | 527 | 396 | 659 | 156 | 566 | 565 | 524 | 65 | 402 | 1776 | 544.9 | 99.1 | 3256 | 17.25 |
| 9.5 | 155 | 454 | 264 | 524 | 232 | 654 | 72 | 541 | 355 | 510 | 43 | 403 | 1121 | 533.2 | 97.0 | 1862 | 17.19 |
| 10.5 | 100 | 472 | 123 | 512 | 111 | 652 | 46 | 529 | 200 | 509 | 29 | 411 | 609 | 526.4 | 95.8 | 1054 | 16.80 |
| 11.5 | 52 | 423 | 76 | 486 | 59 | 650 | 17 | 538 | 108 | 513 | 21 | 369 | 333 | 507.9 | 92.4 | 548 | 16.34 |
| 12.5 | 26 | 450 | 32 | 500 | 37 | 595 | 13 | 441 | 58 | 453 | 13 | 397 | 179 | 485.3 | 88.3 | 285 | 15.96 |
| 13.5 | 15 | 436 | 24 | 447 | 11 | 569 | 6 | 510 | 31 | 470 | 4 | 399 | 91 | 469.8 | 85.5 | 130 | 15.54 |
| 14.5 | 8 | 375 | 5 | 491 | 4 | 550 | | | 13 | 447 | 3 | 360 | 33 | 440.7 | 80.2 | 42 | 15.04 |
| 15.5 | 4 | 392 | 4 | 446 | 4 | 475 | | | 8 | 451 | 2 | 353 | 22 | 434.8 | 79.1 | 24 | 15.41 |
| 16.5 | 2 | 458 | 1 | 395 | 2 | 500 | | | 5 | 465 | | | 10 | 463.6 | | 16 | 15.43 |
| 17.5 | 2 | 376 | 2 | 410 | | | | | 1 | 590 | | | 5 | 432.4 | | 4 | 18.37 |
| 18.5 | 1 | 411 | | | | | | | 1 | 413 | | | 2 | 412.0 | | 3 | 15.50 |
| 19.5 | 0 | | | | | | | | | | | | 0 | | | | |
| 20.5 | 1 | 375 | | | | | | | | | | | 1 | 375.0 | | | |
| | 5162 | | 13599 | | 6085 | | 3949 | | 13723 | | 1014 | | 46002 | | | 104583 | |

*Compiled from the records of Register of Merit Jersey, Record of Merit Shorthorn, Advanced Register of Ayrshire, Guernsey, and Holstein Cattle.

have been determined for the Jersey, Guernsey, and Holstein breeds. Records of fat production may be converted to the mature production by multiplying the actual record by the factor corresponding to the age at which the record was started.

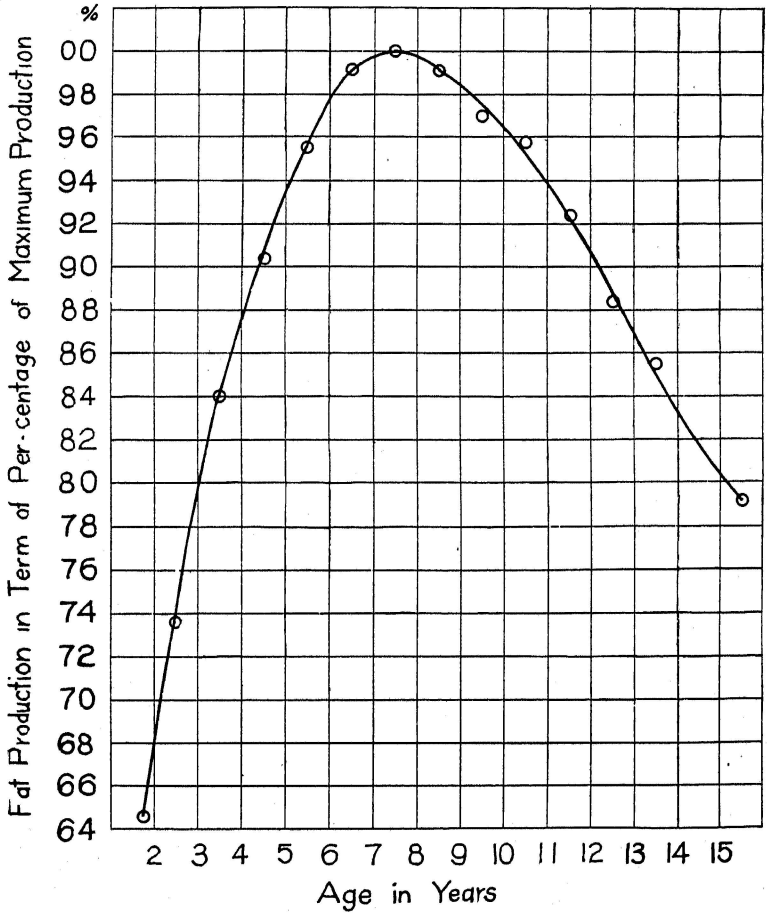


FIG. 2.—THE RELATION BETWEEN AGE AND FAT PRODUCTION EXPRESSED AS PERCENTAGE OF MAXIMUM PRODUCTION. This curve represents over 45,000 yearly records including practically all official records of the Ayrshire, Guernsey, Holstein, Jersey, and milking Shorthorn breeds.

## THE RELATION BETWEEN WEIGHT AND FAT PRODUCTION

It is a common observation that the largest producers of milk and fat are cows above the average in weight or size for the breed. This appears reasonable due to the fact that the larger animals have a greater capacity for feed. The volume of blood is also greater in the larger

TABLE 2.—AGE CONVERSION FACTORS

| Age | Jersey | Conversion factor, Holstein | Guernsey |
|---|---|---|---|
| Under 2 years | 1.484 | 1.473 | ----- |
| 2-2½ years | 1.448 | 1.365 | 1.313 |
| 2½-3 | 1.344 | 1.269 | 1.251 |
| 3-3½ | 1.248 | 1.196 | 1.194 |
| 3½-4 | 1.164 | 1.140 | 1.142 |
| 4-4½ | 1.115 | 1.099 | 1.100 |
| 4½-5 | 1.083 | 1.066 | 1.064 |
| 5-5½ | 1.052 | 1.041 | 1.041 |
| 5½-6 | 1.034 | 1.023 | 1.023 |
| 6-6½ | 1.023 | 1.009 | 1.013 |
| 6½-7 | 1.014 | 1.003 | 1.006 |
| 7-7½ | 1.008 | 1.000 | 1.000 |
| 7½-8 | 1.004 | 1.000 | 1.000 |
| 8-8½ | 1.000 | 1.003 | 1.004 |
| 8½-9 | 1.000 | 1.005 | 1.009 |
| 9-9½ | 1.004 | 1.011 | 1.017 |
| 9½-10 | 1.008 | 1.018 | 1.029 |
| 10-10½ | 1.012 | 1.031 | 1.041 |
| 10½-11 | 1.025 | 1.046 | 1.058 |
| 11-11½ | 1.038 | 1.064 | 1.075 |
| 11½-12 | 1.052 | 1.085 | 1.093 |
| 12-12½ | 1.065 | 1.106 | 1.113 |
| 12½-13 | 1.093 | 1.131 | 1.137 |
| 13-13½ | 1.096 | 1.156 | 1.162 |
| 13½-14 | 1.110 | 1.204 | 1.191 |
| 14-14½ | 1.127 | 1.227 | 1.219 |
| 14½-15 | 1.147 | ----- | ----- |
| 15-15½ | 1.164 | ----- | ----- |

TABLE 3.—AVERAGE WEIGHT OF LACTATING DAIRY COWS

| Age years | Jersey | | Holstein | | Guernsey | |
|---|---|---|---|---|---|---|
| | No. of cows | Average weight | No. of cows | Average weight | No. of cows | Average weight |
| | | *lbs.* | | *lbs.* | | *lbs.* |
| 1½ | 26 | 710 | --- | ---- | -- | ---- |
| 1½-2 | 1001 | 767 | 20 | 1094 | -- | ---- |
| 2-2½ | 3155 | 808 | 165 | 1184 | 34 | 943 |
| 2½-3 | 1449 | 836 | 85 | 1182 | 34 | 969 |
| 3-3½ | 1523 | 872 | 81 | 1249 | 24 | 1028 |
| 3½-4 | 1122 | 888 | 86 | 1285 | 22 | 1093 |
| 4-4½ | 1171 | 916 | 56 | 1352 | 20 | 1090 |
| 4½-5 | 916 | 930 | 87 | 1408 | 12 | 1090 |
| 5-6 | 1692 | 938 | 122 | 1408 | 23 | 1065 |
| 6-7 | 1235 | 945 | 67 | 1428 | 21 | 1141 |
| 7-8 | 965 | 952 | 56 | 1437 | 19 | 1101 |
| 8-9 | 621 | 957 | 36 | 1434 | 14 | 1090 |
| 9-10 | 364 | 962 | 30 | 1443 | 11 | 1184 |
| 10-11 | 208 | 957 | 25 | 1523 | ---- | ---- |
| 11-12 | 108 | 968 | 13 | 1366 | -- | ---- |
| 12-13 | 64 | 956 | 9 | 1375 | -- | ---- |
| 13-14 | 32 | 961 | 8 | 1418 | -- | ---- |
| 14-15 | 14 | 1036 | --- | ---- | -- | ---- |
| 15-16 | 9 | 975 | ---- | ---- | -- | ---- |
| 16-17 | 4 | 963 | --- | ---- | -- | ---- |

animals furnishing a greater supply of nutrients for the formation of milk. On the other hand, it is quite evident that if the capacity of the udder is limited as to secreting cells, the production of milk will also be limited. The persistency of production during the lactation period is another important factor in limiting production.

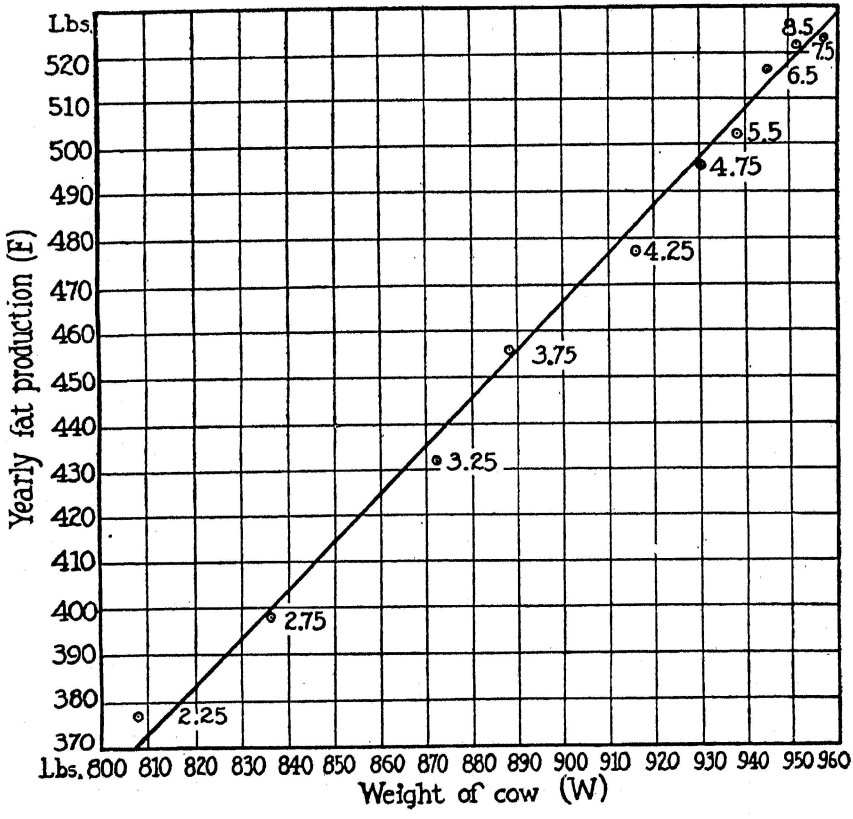


Fig. 3.—The increase of milk secretion with increasing body weight with age in Jersey cattle. The smooth line passing through the observed values was plotted from the equation $F = 1.0423W - 472.32$ in which $F$ is the yearly milk fat production for any body weight ($W$). From this equation an increase of 100 pounds in the weight of the body with age is accompanied by an increase of about 104 pounds of milk fat per year. The numerals on the curve represent the ages of the animals in years.

The relation between weight and yearly fat production for animals in the Jersey Register of Merit was studied. The results are shown in Fig. 3. After the animal reaches the body weight of 470 pounds, there is an increase of 104 pounds in fat production per year for an increase of 100 pounds of body weight with age. Since the Jersey is about 13 or 14 months of age when this weight is reached, the Jersey heifer should be

able to begin secreting milk at this age. This, in fact, is the case as calves have been known to conceive as early as 5 months of age and to calve at 14 months of age.

A study of the normal growth of the lactating Jersey cow using the weight data furnished in the Register of Merit has also been made. The average weight of 15,678 Jerseys classified by age are included. A more limited amount of data on the average weight of lactating Holstein and Guernsey cows is presented in Table 3.

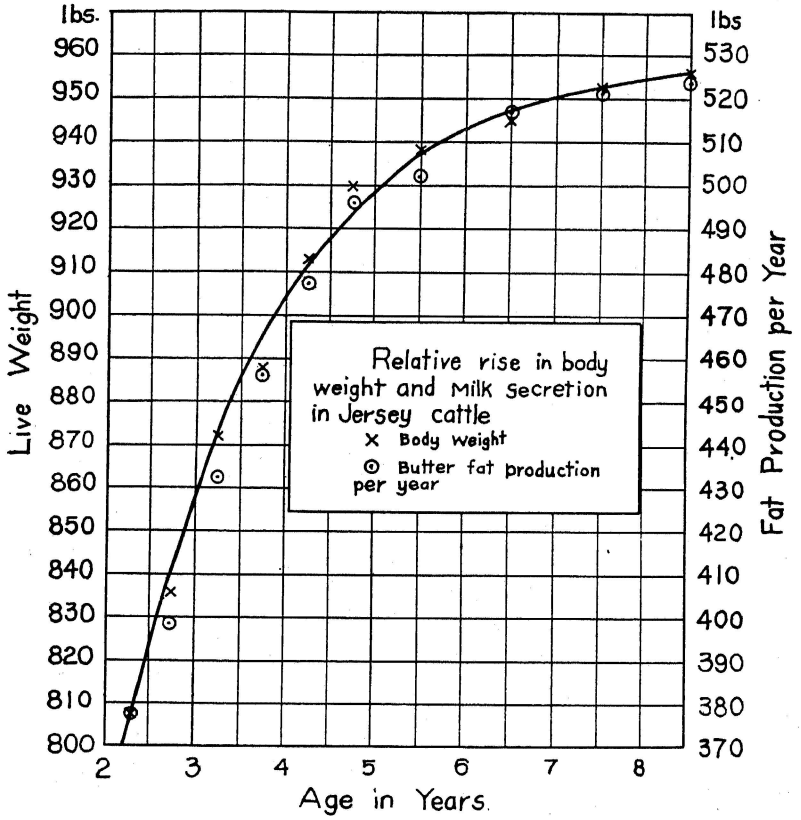


Fig. 4.—RELATIVE INCREASE IN WEIGHT AND FAT PRODUCTION IN JERSEY CATTLE. The increase of body weight with age is indicated by the crosses and the fat production indicated by the circles. It will be noted that both follow the same course.

A comparison of these data show that growth in weight and increase in milk secretion of the Jersey cow follow the same course up to the time of maturity. This parallelism between the growth in body weight and increase in milk secretion with age is shown in Fig. 4. This raises the question as to whether the increase of milk secretion with age is depend-

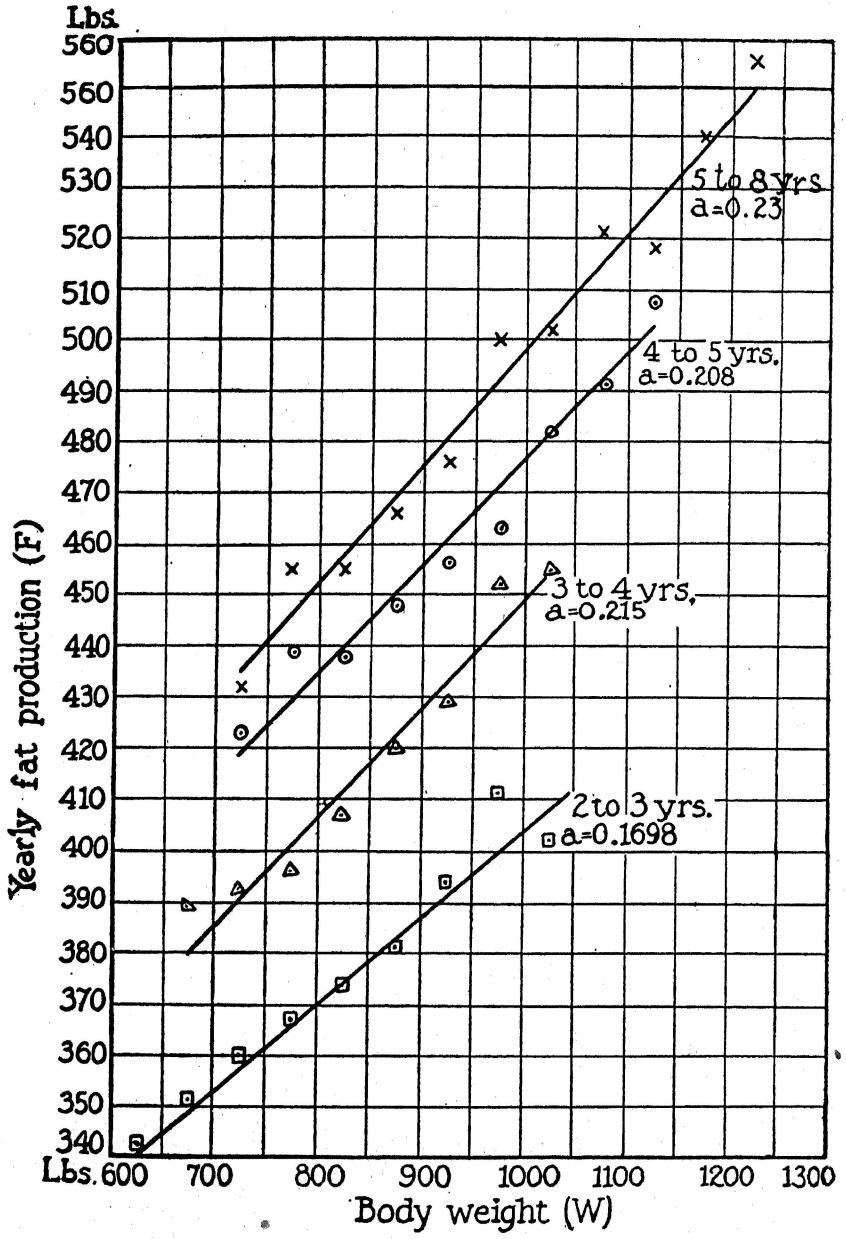


Fig. 5.—The increase of milk secretion with increasing body weight at constant age. The smooth lines passing through the observed values were plotted from the equation $F = aW + b$ in which $F$ is the yearly milk fat production for the body weight ($W$) at the constant ages indicated on the curves; $a$ is the constant increase of yearly fat production for each added pound of body weight. From the values of $a$ indicated on the curves, an increase of 100 pounds in the weight of the body is accompanied by an increase of about 20 pounds of milk fat production per year.

ent on the increase of body weight or whether the increase of milk seecrtion with age is dependent on the development of the mammary gland and other changes of the body aside from increase in weight, consequent to increase in age.

A practical method of making a separation between body weight and age was found by classifying the animals into convenient age-groups and determining the relation between the body weight of the animals within the age-groups and their milk secretion. In addition, the animals were classified as to body weight to determine the relation between the age of the animals within the weight-groups and their milk secretion.

The relation between milk secretion and body weight at constant age is shown in Fig. 5. The relative value of an increase of body weight as compared to the other changes of the body such as development of the mammary glands with age may be estimated from a comparison of the curves. Instead of an increase of 104 pounds of fat for an increase of 100 pounds of body weight, when the age is constant, there is an increase of about 20 pounds of fat for each 100 pounds of body weight. Or stated in another way, at a constant body weight (900 pounds for example) the two-year-old cows averaged 385 pounds of fat as compared to 475 pounds of fat for mature cows. It appears that an increase of body weight contributes about 20 per cent to the total increased fat yield with age, while the other 80 per cent of increased fat yield with age is due to other factors accompanying increased maturity.

This discovery answers the question concerning the relative economy of milk production from cows of different weights. The average value of 20 pounds of butterfat just about covers the feed cost of maintenance of 100 pounds of body weight per year as determined from the feeding standards. In other words, the chief value of large animals, is in the production of larger total yields and in the economy of the same production from an investment in fewer animals and the consequent decrease in overhead costs, rather than in the more economical use of feed by animals of greater size.

From the standpoint of maximum production under official test conditions where size is given little attention and no official recognition, the championships will generally go to the large animals of the breeds, and the larger breeds will hold the largest records. On the other hand, if fat records were equalized by adding or subtracting 20 pounds of fat for each 100 pounds of difference in live weight, there would be little difference between the champions of the various breeds.

NOTE.—Portions of the data presented in this bulletin have been included in several papers published in scientific journals and other publications as follows: Journal of Dairy Science, Volume 6, Number 5, p. 461; Volume 7, Number 2, p. 189; Journal of General Physiology, Volume 6, Number 1, p. 21; Volume 6, Number 1, p. 31; Missouri Agricultural Experiment Station Bul. 206 and Bul. 217.