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AGRICULTURAL EXPERIMENTS

—1927—

New Hampshire
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TABLE OF CONTENTS

AGRICULTURAL EXPERIMENTS 1927

ANNUAL REPORT OF THE DIRECTOR OF THE NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

It has become increasingly clear during recent years that most industries are dependent for their development upon research work. Large manufacturers have found it profitable to set aside funds of no meager proportions for the discovery or perfection of new processes in their experimental laboratories. That similar needs are felt in the field of agriculture is none the less certain. Indeed, the complexity of the agricultural situation—the many people engaging in it and the variety of tasks and organizations—makes it necessary for a much larger volume of investigational work than has hitherto been possible.

The field of agricultural economics, for example, has been comparatively unexplored; yet it is clear that research is none the less needed in the problems of marketing agricultural products than in their production. During the past year, as a result of the Purnell Act passed by Congress in 1925, it has been possible to expand somewhat the work of the New Hampshire Agricultural Experiment Station in this and other fields. Research work in marketing has been started in several important projects. For the first time also it has been possible to enter the field of human nutrition.

The state's poultry operations have increased greatly during recent years, particularly in the number of commercial plants; and this has involved many new problems. The very existence of the industry depends largely upon its ability to control contagious diseases, and the new studies along this line are coming none too soon if disaster is to be avoided.

The fundamental problem of soil fertility in the state has also been attacked further with the institution of new plot experiments at Boscawen and Colebrook.

Of course many of the projects which are conducted almost exclusively under federal funds are of national as well as local interest, involving, as they do, investigations in the field of pure science. The amount of state funds, in fact, is by no means adequate to take care of the different types of service work which are demanded of the Experiment Station by the agricultural problems of the state. New Hampshire is still one of six states receiving state appropriations of less than $10,000.

HOW MUCH LABOR DOES AN ORCHARD REQUIRE?

Comparison between labor requirements of different orchards is very difficult, since differences in age, varieties and conditions of the trees influence labor requirements in pruning, spraying, picking, etc.

However, it is believed that over a period of years certain characteristics for the different operations and their seasonal distribution may be obtained. With this in view a detailed study of the cost of the production of apples was started in the spring of 1926 in co-operation with the Bureau of Agricultural Economics of the United States Department of Agriculture. The study is conducted on a route of ten farms in southern New Hampshire by H. C. Woodworth, G. F. Potter and H. A. Rollins. Of the ten farms four are highly specialized fruit farms, selling practically nothing but apples. One has poultry and fruit, and five have more or less diversification. One produces apples, potatoes and beans for sale; another, apples, sweet corn, snap beans, peaches, peas, strawberries and milk; a third, apples and strawberries; the fourth, apples, asparagus, strawberries and broilers; and the fifth, apples, strawberries, beans, potatoes and hay.

The orchards vary in size from 565 to 3,100 bearing trees, with a total of about 13,650 bearing and 2,600 non-bearing trees on the ten farms. Approximately 36,000 boxes were harvested in 1926, an average of 3,600 per farm, with a labor requirement of 24,415½ hours, not including grading and packing.

The operators vary in personnel from older men of 65, who are seeking to make a living from apple production without too strenuous a physical life, to vigorous young men who are under the necessity of meeting current expenses and paying for the farm.

The group is believed typical of the bulk of the trees in New Hampshire commercial orchards, which, planted largely between 1910 and 1925, have been built up around a block of much older trees. Most of the trees are young and by no means yet in full bearing. This will explain the fact that although a fair crop was harvested, it amounted on the average to only three packed boxes per tree.

The ten farms do not follow uniform methods of disposing of apples. Two operators put all but a few early apples through the co-operative packing plants, hiring trucks to take the fruit from the farm as picked. Three others sold most of the apples practically tree-run at the farm. Five graded and packed their own crop.

The total time requirement for the year 1926 was approximately 107 minutes per tree, or 40 minutes per box. Prior to harvest the total labor requirements were 10,140 hours, or 44.6 minutes per tree, and 18 minutes per packed box. The harvesting of apples required 60 minutes per tree and 22.9 minutes per box. In addition, there was a miscellaneous labor expense of 571¼ hours, or 2.5 minutes per tree. Some of the orchards had above normal yields and some below, but the figure of 107 minutes per bearing tree and 42 minutes per box is thought to represent a cross section of conditions among the commercial growers in 1926. This time includes the labor on 2,600 non-bearing trees, which range from one to eight years of age, and, being grown by the sod mulch

A year's prunings in orchard of A. D. Colburn of Hollis, one of those where time studies were made.

system, have required little work. The work on these is assumed to approximate the requirement of replacing and maintaining the 13,650 trees. Later the labor requirements on different ages of orchards will be analyzed separately as far as possible.

The approximate average human labor requirements per tree on all the orchards were as follows: pruning, 11 minutes; brush disposal, 4 minutes; spraying, 9 minutes; fertilizing, 2 minutes; tillage, 5 minutes; setting and resetting, 1 minute; mowing, 4 minutes; mulching, 1 minute; protection, 1½ minutes; thinning, 4 minutes; propping, 1½ minutes; harvesting, 60 minutes; miscellaneous, 2½ minutes. Total, 107 minutes.

Dividing the time by months, and using a weighted average of the requirements per tree, it was found that a block of 1,000 trees for the year required 190 hours in April, 144 hours in May, and 130 in June, 87 in July, 108 in August, 328 in September, 609 in October, 92 in November, 3 in December, 5 in January, 11 in February and 83 in March. A study of these figures suggests that 1,000 trees may well be considered a minimum unit for specialized fruit farms. Prior to harvest, 190 hours was the largest labor demand in any single month. The operation of such a farm would require either co-operation with neighbors or the employment of help at certain seasons because it is not practicable for one man to do some of the work alone. The figures do suggest, however, that as far as time required is concerned and as now operated, a 1,000-tree orchard represents not more than a one-man proposition. (Purnell Fund.)

CULTIVATING AND FERTILIZING THE APPLE ORCHARD

For 18 years the Station has been securing records from the Woodman orchard on trees growing under various cultural conditions: trees in sod with no fertilizer, unfertilized trees cultivated in alternate years, trees cultivated but not fertilized, trees cultivated which receive in addition 2 pounds nitrate of soda, 4 pounds sulphate of potash, and 8½ pounds acid phosphate or its equivalent in basic slag per tree, and trees which receive in addition to the cultivation and complete fertilizer listed, an additional amount of acid phosphate in the one case, nitrate of soda in another, and sulphate of potash in the third.

Previous publications have indicated during the first ten years of the experiment some increased growth on the plots receiving fertilizer but no significant increase in the average annual yield. During the last eight years, however, the yield of the trees has been very materially influenced by the fertilizer treatments. There are apparently four general classes in order of yield as follows beginning with the lowest: (1) trees growing in sod without fertilizer; (2) trees cultivated without fertilizer; (3) trees cultivated and receiving either the complete fertilizer alone or with extra phosphorus and potash; (4) trees cultivated with complete fertilizer and 4 pounds of extra nitrate of soda per tree. The yields for the season of 1927 show a general relation to the average for the past eight years although, as may be expected, the crop in any one season is likely to show some fluctuations. The crop in 1927 was not large. The high yield usually harvested from the high nitrogen plot was reduced to about 60 per cent of that ordinarily harvested. The size of fruits was large in all except the sod plot on account of abundant rainfall during the latter part of the season.

Twig measurements do not show the striking differences which were evident during the early history of the experiment. This may be due to the fact that those plots which grew most rapidly are now suffering from lack of light in the lower branches. In girth of trunk the different plots remain in about the same relation as in previous years.

Time of Application

The work on the effect of time of application of nitrogenous fertilizers on size of apple fruits, set of blossoms, and fruit bud formation, has been continued by G. F. Potter in the orchard at the Horticultural Farm and upon a co-operative basis in the orchard of A. F. Rockwood of Temple, N. H. These results indicate at the present time that midsummer applications of nitrogen made during the period of active growth of the fruits do not influence the ultimate size of the individual apples. There is some evidence that they have a marked effect upon the set of blossoms the following spring.

Observations on the fruit habits of the McIntosh under various treatments have also been made in two orchards. During 1926 different fertilizers were applied as follows to several plots of 18- to 20-year-old McIntosh trees in an orchard belonging to C. E. Hardy of Hollis, N. H.: nitrate of soda about two weeks prior to the bloom period at the rate of 5 pounds to a tree; ammonium sulphate at a similar rate; and a complete fertilizer consisting of approximately 5 pounds of nitrate of soda, 3 pounds of acid phosphate, and 3 pounds of muriate of potash

per tree. Measurement of twig growth showed that the applications of nitrate of soda and ammonium sulphate increased growth approximately 25 per cent over the check plot, and a complete fertilizer gave a somewhat equivalent increase. In no case was there evidence that the diameter of the new growth was affected by the fertilizer treatment.

It is somewhat surprising, also, in view of the marked differences which had been produced by the fertilizer treatments on the set and the crop to find no influence on flower formation. However, it is an accepted principle that a heavy set of flowers followed by the production of a good crop of fruit has a tendency to inhibit fruit bud formation. The fact that the trees which received fertilizer set and carried a heavier crop than those which did not, would tend to decrease flower formation and evidently counteracted any tendency of the fertilizers to increase the formation of flower embryos.

Similar observations were made on older trees on the University farm. There nitrate of soda was applied two weeks before bloom and two weeks after bloom. The date of application did not appear to affect significantly either the average annual twig growth, or the proportion of flower buds formed. (Adams Fund.)

CHEMISTRY OF FRUIT BUD FORMATION

The importance of ascertaining the relation between the chemical constituents of fruit spurs and fruit bud formation may be easily seen and for several years work has been in progress at the Station on this subject. The use of a new method for the rapid calculation of the correlation coefficient has been followed by G. F. Potter and T. G. Phillips on 26 different plots. The data, which are still being analyzed, indicate that both soluble and insoluble nitrogen have a very definite relation to fruit bud formation. On July 1 the per cent of starch showed a definite positive correlation with the size of the spurs; but by August 1 this relation had disappeared, and the starch content in spurs of the same size did not seem to affect one way or another the proportion of fruit buds formed.

FERTILIZING PEACH TREES

The importance of nitrogen in peach culture was shown in studies last year of different plots in one orchard receiving various fertilizer treatments.

The plots which received nitrogen, either alone or in combination, had an increased trunk diameter and an increased average yield per tree of approximately 7½ pounds.

In this season, as in 1925, a decided benefit appeared from the use of muriate of potash in addition to nitrate of soda; the trees receiving this treatment yielded nearly 8 pounds more than those which were given nitrogen without the potash. This does not appear to be due to any increase in the growth or size of the tree. The potash treatment increased the yield of peaches in two seasons in which the moisture supply was abundant, but did not do so in 1926, which was rather dry. (Hatch Fund.)

VARIETY TEST OF FRUITS

Observations on adaptability of varieties of apples, pears, plums, cherries, and small fruits to New Hampshire conditions have been made by G. F. Potter, L. P. Latimer and L. R. Tucker.

The present tendency in apple production in New Hampshire is toward standardization on the commercial varieties McIntosh, Baldwin, Gravenstein, Spy, Delicious Wagener and Wealthy, which are all admirably adapted to our soil and climatic conditions.

The principal question regarding varieties before New Hampshire apple growers is as to the advisability of substituting some other variety in place of the Baldwin for the late winter markets. The two varieties most frequently considered are Delicious and Cortland. The Delicious and its newer red sport, Starking, are under extensive test in the Station orchards on a scale which will make it possible to determine with reasonable accuracy the relative commercial value of this variety as compared to Baldwin. The trees, which were planted in 1923 under sod culture on rather low land, show much better growth than the Baldwin trees planted alternately with them. Observations on this variety in a few commercial orchards in the state where it is in bearing, indicate that the fruit as grown here is rather smaller than that which the public is accustomed to receive from the Pacific Northwest. Its color and quality are excellent, and it is possible that when the buyers become acquainted with this type of Delicious they will prefer it to the western product. This, however, is a problem in marketing which it will require some time to solve. Aside from size, the variety has one serious defect as grown under New Hampshire conditions, namely that it is very subject to water core. It is thought possible that the red strains may be so handled in the orchard as to avoid this trouble, the superior color rendering it possible to pick the fruit at an earlier date.

Twenty-five trees of Cortland planted in 1924 are making very satisfactory growth but have not as yet produced fruit. A few trees of this variety are now fruiting in commercial orchards in the state. Although opinions vary, it appears to be of rather better quality than the Baldwin at the same season, and not as good as the McIntosh. Its value for planting in New Hampshire orchards should depend, therefore, upon its ability to keep later than the McIntosh for sale during that period of the year when Baldwins are now principally offered.

Pears

Observations were made on pear varieties in two orchards, one in sod in relatively thin dry soil, and the other in a relatively heavy soil under cultivation.

As in previous seasons, the Flemish Beauty trees showed the greatest promise. The trees were relatively healthy and vigorous and bore the heaviest crops. The only drawback is their susceptibility to scab.

The Bartlett pears in the sod orchard bore heavily of first class fruit, although the trees were rather low in vigor.

The Clapp Favorite trees were vigorous and produced fine large fruit of high quality. Kieffer was next in vigor and productivity, but the fact that the fruit is low in quality and matures late makes it of less value than other varieties. (Hatch Fund.)

POLLINATION OF McINTOSH AND BALDWIN APPLES

With the greatly increased production of McIntosh apples in New Hampshire the problem of pollination is exceedingly important, since this variety has shown many indications of poor set due to lack of fertilization of the blossoms.

Work on this project was begun by L. P. Latimer in 1927, and, in spite of the handicap of continuous rain during the blooming period, has yielded significant results.

Cross pollination was conducted on a screened McIntosh tree and a bagged Baldwin tree. These experiments were supplemented with counts of set of fruit under field conditions on McIntosh trees interplanted with different possible pollenizers.

Good bloom is not enough. McIntosh trees were found self-sterile in the Station's experiments.

Pollination of McIntosh

One entire McIntosh tree was enclosed in a wire screen cage to exclude bees and other insects which are known to transfer pollen. All flowers that were open were hand-pollinated on certain dates; others were left as checks to determine if there was any self-fertilization in McIntosh flowers. On the average, four flowers were hand-pollinated in each cluster. Every flower in an individual cluster received the same variety of pollen. Different clusters on the same shoot and even on the same spur were pollinated with different varieties.

The results show that in 1927 McIntosh was practically self-sterile and Wagener and Delicious were the most reliable pollenizers. Baldwin proved to be the poorest pollenizer for McIntosh of the varieties tested. The other varieties, Wealthy, Gravenstein, Delicious and Red Astrachan, gave fairly satisfactory results.

In the case of Delicious and Wagener pollen there was little loss of fruit after July 7, and no significant loss in the number of clusters retaining at least one fruit. Where Astrachan was used, little more than half the fruit counted on July 7 remained on the tree at maturity, September 9. The kind of pollen seemed to have no significant influence on the size of the fruit developed, although the Astrachan-pollinated fruit was consistently largest.

The results of normal set of fruit in orchards open to insect pollination also showed the Wagener and Delicious the best pollenizers for McIntosh.

Pollination of Baldwin

Hand pollination by the bagging method was performed on one Baldwin tree using three pollen varieties: Delicious, Wealthy and Gravenstein. The most satisfactory set of fruit was obtained with Delicious pollen. (Hatch Fund.)

CAN WINTER HARDINESS BE MEASURED BY DYES?

Studies on absorption of certain aniline dyes by pulverized apple twig tissues by Dunn and Bakke in 1924–25 at Iowa State College indicated that this test might have some value as a means of determining relative hardiness; and during the past year studies were made here by Mr. Dunn on samples of twigs obtained at the close of the growing season. Twenty-two well-known commercial varieties of apples were used possessing a gradation in resistance to unfavorable weather conditions from extremely hardy down to the rather tender. Among the more hardy were such varieties as Hibernal, Patten Greening, McIntosh, Oldenberg or Duchess, Wealthy, Virginia Crab and Red Astrachan. At the other extreme among the markedly tender varieties were Ben Davis, Stayman, Winesap, Baldwin, Delicious, Maiden Blush and Roman Stem. Somewhere between these extremes will be a group exhibiting moderate hardiness, such as Malinda, Fameuse, Peerless, Salome, Grimes Golden, Northwestern Greening, and Yellow Transparent. In these samples a better correlation than the year before was found between the results of the adsorption tests and groupings according to hardiness. About five or six varieties were out of agreement. The readings varied from .018 in the case of a hardy variety to .105 in the case of a tender one, the figures representing the fraction of dye left in solution after adsorption. (Adams Fund.)

WHEN DO FUNGICIDES DAMAGE PLANTS?

One of the handicaps in the use of Bordeaux mixture has been the injury caused by various combinations of this fungicide on the plants. Studies conducted by O. Butler during recent years have shown that the injuries are caused where the proportion of lime in the mixture is low. When four times as much lime as copper was used, no injury resulted on the apple, although it was necessary to make the proportion six to one in the case of peach.

During the past year these studies dealt particularly with the relation of meteoric water, dew and rain. It was found that the peach and apple suffer no injury from spraying provided the foliage is protected from dew and rain. When such precaution is not taken, however, injuries decrease as the per cent of lime in the mixture increases. (Adams Fund.)

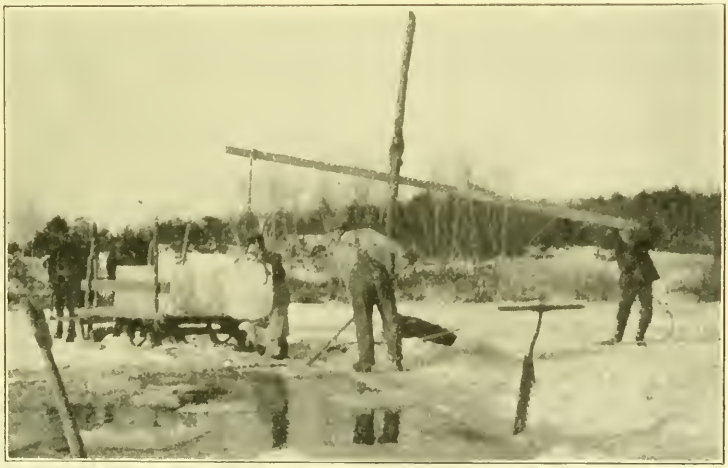
CONTROL OF BITTER-PIT

Indications that the disease of bitter-pit of apples is more serious in the "off years" of Baldwin trees are suggested in studies that have been conducted by O. Butler. In 1924, when there was a heavy apple crop, an average of only 2.38 per cent of bitter-pit was found. The next season, which was an off year with a light crop, the percentage of bitter-pit jumped to 18.87, while in 1926, a productive year again, it was only 1.40. The mean weight of fruit produced per tree in 1924 was 443.38 pounds; in 1925, 25.32 pounds; and in 1926, 352.45 pounds. (State Fund.)

ELECTRICITY AND THE FARM

Seven farms in New Hampshire, representing dairy, poultry, fruit and general farms, were selected in the spring of 1925 in a co-operative project for the New England area with State and National Committees on the relation of electricity to agriculture. The farms were equipped with appliances to determine what limits in quantity of electricity can be economically used and to secure data on the efficiency of the different appliances. They were chosen as typical of substantial and successful enterprises operated with modern, well-balanced methods.

Sixty major and 40 minor pieces of electrical equipment are now in use on these farms covering 36 distinct operations and metered in such a way that detailed records can be secured each month for nearly every appliance. The work is in charge of W. T. Ackerman.



This is a chore now eliminated where electric dairy cold storage has been installed.

Current consumption on the seven farms averaged 1,683 kilowatt hours for the year 1925 and increased to 4,253 kilowatt hours in 1926.

Heating equipment, such as refrigeration, ranges, ironers, water heaters, etc., produced the greatest effect on the total consumption and developed a peak load in midsummer.

Total consumption for the year 1926 was distributed as follows: winter, 23 per cent; spring, 16 per cent; summer, 32 per cent; and fall, 28 per cent. Total consumption by farms for 1926 ranged from 432 kilowatt hours for the fruit farm to 7,694 kilowatt hours for one of the dairy farms.

The records are still too limited to draw many detailed conclusions, and further research, particularly with farmstead appliances, is desirable.

House lights showed an average monthly consumption of 34.6 kilowatt hours, ranging from 15.2 to 63.3; water pumps of 23.7 kilowatt hours, ranging from 3.7 to 39; kitchen ranges of 167 kilowatt hours, ranging from 26 to 282 (combination ranges with wood and coal and straight electric

ranges are being used); house refrigerators, an average of 35.3 kilowatt hours per month, ranging from 23 to 39.5; hot water heaters, an average of 182 kilowatt hours per month, ranging from 15.2 to 548; washing machines, an average of 2.6 kilowatt hours per month; flatirons, 7.3 kilowatt hours per month, and ironing machines 12.7; barn lights, an average of 7.9 kilowatt hours per month, ranging from 4.3 to 13.9; milking machines, an average of 91.5 kilowatt hours per month, ranging from 56.5 to 134; dairy cooling rooms, an average monthly consumption of 119 kilowatt hours, ranging from 96.5 to 148.

Detailed results of the studies have been published in Bulletin 228. It seems certain that electricity will have a wider range of usefulness on New England farms, if properly guided, and may have a far-reaching effect on the labor situation and increasing the margin of profit for the producer if reasonable rates are provided by the power companies. A special rate for agricultural use has been provided by schedules already published by several leading companies. The desirability of the rural electric load, from the power companies' standpoint, is much better than expected and may be developed to improve the present power factor, probably without increasing their present equipment. (Miscellaneous Income.)

STUDIES OF GRAIN COSTS

Great variations in the efficiency of handling grain are indicated in the results of a statewide survey of the retail feed and grain stores of New Hampshire. The survey, conducted by E. H. Rinear, who obtained data from 197 stores, found that gross margins charged by dealers over wholesale prices ranged from $2 to $12 a ton, with the large majority charging between $4 and $6 a ton.

Credit, delivery and volume of business were found to be important factors in the cost of handling grain; and total costs varied from $2 to $10 a ton, with the majority ranging from $4 to $6. In other words, the average grain dealer in the state is apparently only "breaking even." Efficiently operated stores with a large volume of business were found handling as much as $60,000 of yearly sales per person employed, while others were handling as little as $5,000. Practically every store in the state was visited in the survey.

One of the outstanding features was the lack of systematic accounting. Many dealers did not have any record of yearly costs and could furnish only meager estimates of their business. Of the 197 dealers, 44 per cent furnished fairly accurate accounts; 48 per cent gave estimates; and the remainder, or 8 per cent, did not have any record.

The survey showed that 212,393 tons of feed and grain were sold in New Hampshire during 1926. Fifteen per cent was sold at the car-door, 62 per cent at the store and 22 per cent was delivered to the customers.

Following this preliminary survey the grain dealers of the state were invited to attend a conference at the University where the facts shown in the investigation were presented. One of the results of this meeting has been the formation of a set of suitable accounts for use by grain dealers. (Purnell Fund.)

DISCOVERING THE BASE-LINE OF ANIMAL NUTRITION

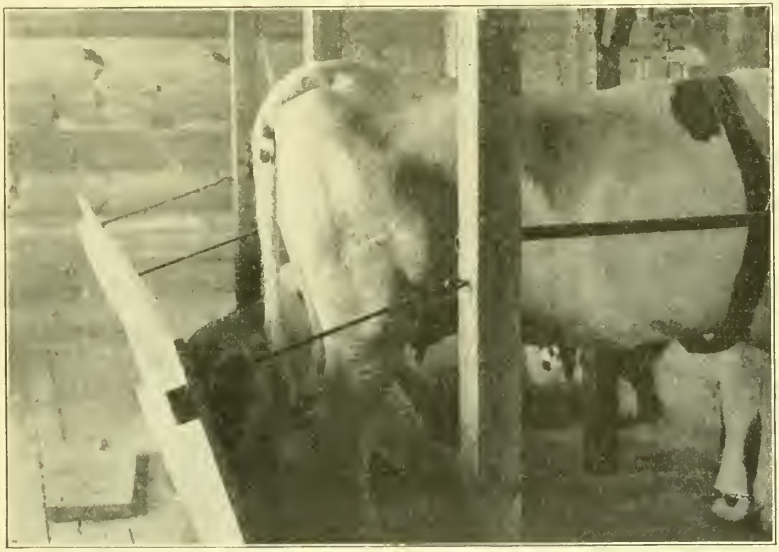
The determination of the feed level needed to hold animals at mere maintenance—that is, a condition where there is neither gain nor loss in body tissue—is of fundamental importance to an understanding of animal nutrition.

This has been one of the principal objects of the studies conducted in co-operation with the Nutrition Laboratory of the Carnegie Institution of Washington, using the new type of respiration chamber designed by Dr. F. G. Benedict. Messrs. Benedict and Ritzman have studied steers while fasting and while on different levels of subsistence, ranging from undernutrition to heavy fattening rations. They find that when the food supply is below maintenance requirements, or when it is entirely cut off, the demand for energy to maintain life is thrown on the organism itself to meet this deficiency. Thus profound changes may be expected in the adaptation of vital activities to this new situation. Life itself now becomes a defensive scheme, and readjustments are made to secure a minimum demand upon existing stores of energy.

Incidentally, these studies demonstrate that steers may be carried through a period of three or four months on extraordinarily low rations without affecting their general health or lessening their power to regain a suitable market condition with subsequent liberal feeding—a conclusion of practical value to the stockman.

The important fact, however, that the bovine has a remarkable capacity to accelerate or to slow down its vital activities in accordance with the available supply of food has given an entirely new basis of attack on the problem of basal requirements for maintenance.

These basal requirements—an economic overhead in feeding live stock—form the only logical foundation for comparison of the relative heat or



Cattle in metabolism stalls used in studies of animal nutrition.

energy production between different individuals and between different species.

Under as nearly comparable conditions as it was possible to obtain to those of non-ruminants, the basal heat production of steers was found to be 1,300 calories every twenty-four hours per square meter of body surface, or more than twice that (600 calories) found in the white rat and much in excess of that found in humans (925 calories for men and 850 calories for women).

In this relatively small group of warm-blooded animals, therefore,—the man, the steer, and the rat,—there is a variability ranging from 600 to 1,300 calories per twenty-four hours. The heat production of the steer under conditions comparable with man is fully 40 per cent greater. Thus, the laws governing heat production and heat loss may be very different with different types of animals. Indeed, it is possible that the two processes are to a considerable extent independent of each other.

Other Observations on Fasting

With ruminants the food residues in the intestinal tract are very large, amounting at times, in the case of the steer, to one-fifth of the entire body weight. The possibility of these residues serving as a source of energy for a considerable period has long been assumed.

The studies in the respiration chamber, however, have definitely shown that live weight losses are no indication of real tissue changes. Nitrogen losses indicate drafts upon body protein; but for sustaining the life processes during fasting, by far the largest draft upon the body stores is made upon fat. With steers the experiments showed a distinct tendency for the fat to fall off rather rapidly during the first one or two days of fasting. As fasting continues, however, the heat or energy production continually and regularly declines.

The general behavior of fasting steers leads to the deduction that the so-called "hunger feeling" is merely the temporary sensation caused by physical contraction of the alimentary tract to meet requirements of a diminished bulk. In no sense does it represent distress due to lack of nourishment of tissues. After the second day no particular irritation or craving for food was manifested.

Equipment and Technique

Noteworthy changes and improvements in equipment and technique have been made in gas analysis. With the new apparatus now installed the capacity of the operator in determinations of carbon dioxide, oxygen, and methane gas has been trebled.

A small respiration chamber for individual sheep has also been installed to supplement some of the earlier work done in groups on sheep.

This apparatus is designed entirely on new lines and, if successful, will simplify materially the problem of indirect calorimetry. (Adams Fund.)

TWIN-BEARING SHEEP MORE PROFITABLE

Fecundity in Sheep

Experiments with sheep are now under way to increase the inherent fertility of the flock so that twins will be the rule rather than the exception; in other words, to establish a twin-breeding strain. This work has been conducted by E. G. Ritzman with the co-operation of C. B. Davenport, director of the Department of Genetics, Carnegie Institution of Washington.

Much argument has always been advanced in favor of single lambs; but the results of the breeding work have definitely established the fact that twins will grow as rapidly and to as large a size as singles provided they are born healthy and receive an abundance of milk from their dam.

Relation of Milk Yield to Growth of Lambs

These studies indicate that ewes kept for the purpose of raising marketable lambs should be selected with as much care as cows kept for the dairy.

The difference in weight increase between lambs from high-milking ewes and good-milking ewes was found to be 16 per cent; between high and fair-milking ewes, 38 per cent; and between high and poor-milking ewes, 79 per cent. The increase in weight of lambs was almost directly proportional to yield. In four-week periods the greatest rate of increase was found in the second period for all groups. A slight decline in the rate of growth was found in the third period, except in the low yield, and this was followed by a still further decline in the fourth period. Since all lambs had free access to a liberal amount of grain and hay, which they ate greedily as they grew older (third and fourth periods), the controlling factor must have been the milk.

Fat content of milk was found secondary to quantity, since lambs increased correspondingly in weight on milk varying in fat from 2 to 10 per cent. The increase from the milk richest in fat was no greater than that from the milk which had the lowest fat content. In fact, the highest gains (37 pounds) were on 2 to 3 per cent milk, and the lowest gains (18 pounds) on milk testing 10 per cent or over. The limiting factor in this case was apparently the quantity of milk, as the high gains were made from good to high milk yield, and the low gains from poor to fair yield.

Inheritance of Size and Conformation in Cross-Bred Sheep

Experiments to determine the nature of inheritance of size and of conformation or proportion of parts indicate that a new race, or type, can be established in a relatively few generations of breeding. In a size cross of sheep the mean body measurement of F_1 and F_2 offspring are both between the mean size of their parentage.

A greater range of sizes exists in F_2 than in F_1; but neither exceeds the size of either the large or the small foundation parent and both differ from the foundation parent, and even from each other in the proportion of parts.

The results obtained here on size inheritance with sheep accord on the whole very closely with those of other investigators on size inheritance with mammals generally. Perhaps the most outstanding feature, in so far as it may throw some light on the practical side of animal breeding, is that observed by other investigators to exist in humans, in albino rats, and in

rabbits; namely, that in size crosses different characters do not inherit equally. This phenomenon, together with the generally observed increase of variability in the second cross, accounts no doubt in a large measure for the discredit into which continued inbreeding has fallen in the popular mind, in spite of the fact that the history of our standard breeds shows that, in the establishment of new breeds or combination of traits, success depends largely on the most rigid culling of the undesirable elements and the most intensive inbreeding of the selected stock.

In studies of the wool characters of the animals used in the cross-breeding experiment fleece weight was found to be considerably affected

Multi-nippled sheep from Alexander Graham Bell flock, result of 35 years of selective breeding.

by age, feeding, and general environmental conditions, and was, therefore, very difficult to analyze genetically. Fineness of wool is evidently controlled by multiple factors, and together with length of fiber tends to diminish in successive generations in the Southdown and Rambouillet cross, but there seems no physiological dependence of small diameter on shortness of fiber. Crimpiness is also intermediate in its mode of inheritance, though there is an inclination of the F_1 toward the more crimpy parent. The relation between crimp and diameter of fiber does not seem significant, though a positive correlation was found. (Adams Fund.)

PHYSIOLOGICAL STUDIES OF DAIRY COWS

The studies of nutrition of dairy cows have indicated a need for greater knowledge of the physiology of the animal under herd conditions. More definite figures of how a cow spends her day were desired. Observations of the 49 different cows in the University herd made by J. M. Fuller indicate that the amount of time spent standing and lying is approximately equal, the exact figures being 51.33 per cent time standing and 48.67 per cent time lying. Breed may have had a slight influence, Ayrshires standing 50.63 per cent of time, Guernseys 52.79 per cent, Holsteins 53.8 per cent, and Jerseys 47.24 per cent.

Studies were made of the time spent in eating, deglutition, rumination, and regurgitation, as well as of respiration and pulse rates; and a bulletin reporting on the project will be issued shortly. (Purnell Fund.)

THE VISCOSITY OF ICE CREAM

In the commercial manufacture of ice cream one of the most important factors is the viscosity of the mix. Studies conducted by H. F. DePew show that there are two kinds of viscosity, one apparent, and the other, which is of the most importance, real or basic.

The results show that both the apparent and the basic viscosities of the mix are increased by: a greater concentration of solids in the mix, an increase in the per cent of gelatin in the mix, a decrease in the temperature of aging the mix, and homogenization.

Homogenizing the mix at a temperature of 145° F. gave a greater viscosity reading than did a temperature of 110°. The rapidity of cooling the mix did not seem to affect the viscosity. Both of these statements are contrary to ideas commonly held.

An excessive viscosity increases the time required to obtain overrun in the ice cream, and decreases the amount of overrun obtained. Extremes in viscosity produced a difference in the texture of the ice cream. A very viscous mix produced a smoother ice cream than a very thin mix. However, no difference in texture could be detected in samples where the difference in homogenizing pressure was 500 pounds or less. (Purnell Fund.)

TREATMENT OF WORN-OUT HAY LANDS

An extensive series of experiments to determine the best methods of rejuvenating the large areas of worn-out hay lands in the state is already under way in representative sections. The studies, which are being made under the supervision of Ford S. Prince and T. G. Phillips, now involve three main series of plots. One of these on the Whenal farm in Greenland deals with grass; another on the same farm with legumes; a third on the Carter farm at Boscawen is concerned with a dairy farm rotation. These experiments are of a long time nature, and the significance of the results will be most evident after a series of years.

Experiments with Grass

This experiment was started in 1925. There are 63 plots, 12 of which represent the original sod, while 51 were plowed and reseeded with a mixture of fifteen pounds red top and four pounds timothy per acre.

Twenty-four of these plots were manured, and twenty-seven were not. On the manured plots a stand of grass was secured. Due to a lack of moisture, the low fertility of the soil and somewhat to grasshopper injury, very little grass lived on the unmanured plots. These were all reseeded in August, 1926, and a stand was secured on all but six of the plots. These six were seeded again the last of March, 1927, but no harvest was taken from them.

The average yields for the plots harvested in 1926 and 1927 show wide variations, and there may be some question about their significance due to a lack of uniformity in the stand of grass. The rainfall was greater in 1927 than in 1926, and the hay yields are consistently higher.

On the face of the figures presented 100 pounds of nitrate of soda have given an average increase for the two years of 262 pounds of hay on the

unplowed plots, 774 pounds on the manured plots and 867 pounds on the unmanured plots in 1927. The nitrate was applied on the unmanured plots in August, 1926, just after seeding. None was applied on these plots in 1927.

Two hundred and fifty pounds acid phosphate gave a loss of 47 pounds on the manured plots and a gain of 1,314 pounds on the unmanured plots in 1927. There has been consistent evidence that acid phosphate has been effective in helping secure a stand where no manure was used, but so far it has returned nothing where used with manure alone.

The combination of acid phosphate and nitrate of soda gave an increase for the two years of 866 pounds on the manured plots and 1254 pounds on the unmanured plots in 1927.

The lime plots have shown a consistent increase in hay yields both for the two- and four-ton applications.

Experiments with Legumes—Alfalfa

In the studies on alfalfa 48 plots of one twentieth of an acre in size are used, with a basic treatment before seeding of 20 loads of manure and two tons of ground limestone per acre.

The land for the alfalfa was plowed up from the original sod in October, 1925. The lime, manure, acid phosphate and potash were applied in May and June, 1926, and worked into the soil. The alfalfa was seeded June 23, 1926, and the nitrate of soda was applied just after the young plants came up on those plots which received that material. Although the alfalfa attained a height of about 30 inches in August, no harvest was made in 1926 for fear of weakening the stand. The first crop was cut in June, 1927, and the second in August. No fertilizers were applied in 1927 on the alfalfa plots.

The yields for the first and second cuttings and the gain over the check plots have been correlated and show a striking uniformity of yields with the different treatments.

Of the chemicals, potash is the only one which, when applied singly, gave a significant increase. This is true for both cuttings.

Of the other treatments, manure, manure and phosphorus, and manure, lime and phosphorus, gave significant increase in the first cutting, while in the second cutting those mentioned together with manure and lime, manure, lime, nitrogen and phosphorus and manure, lime, nitrogen phosphorus and potash are significant.

Sweet Clover

Thirty-two plots in the experiment were seeded to sweet clover June 3, 1926, and managed essentially the same as the adjoining alfalfa experiment.

While it would have been desirable to pasture the various plots in this experiment, it was not possible to do so on account of their distance and comparatively small size.

No harvest was made in 1926, although the crop made an excellent growth, especially on those plots which received manure. The plots were harvested in June, 1927, and cured as hay.

Manure appears to have had the most effect on sweet clover, although significant increases were obtained from all treatments, except lime and

phosphorus where used alone. Other fertilizers used with manure, with the exception of potash, were additive.

Dairy Farm Rotation

This experiment, embracing 120 plots, was started in 1926, when the land was fall plowed and lime applied to certain plots at the rate of one, two and three tons per acre.

In the spring of 1927, the field was manured uniformly at the rate of 12 tons per acre, and a basic treatment of 300 pounds of acid phosphate was applied. Certain plots were then fertilized with 300 pounds acid phosphate, 150 pounds muriate of potash and the two together. The whole field was planted to silage corn.

Of the increases recorded all those are significant on plots which had

Some of the sweet clover plots in soil fertility studies at Greenland.

two or three tons of ground limestone, either alone or in combination with phosphorus and potash. The only other significant increases are those on plots where one ton of lime was applied with potash alone or in a mixture.

It would appear, therefore, that lime and potash have had considerable effect on the growth of silage corn. (Purnell Fund.)

Pasture Improvement

Two areas on the University farm, one on a good, the other on a poor, pasture were laid out by F. S. Prince and divided into four twentieth-acre plots in the spring of 1926. One of the plots on each area was plowed; all were limed and treated with 500 pounds acid phosphate per acre. No manure was used.

The plowed plots were seeded in May, 1926. A perfect stand of sweet clover was secured on the plot in the good pasture, and about a half stand in the poor pasture.

One plot in each area was disked and seeded. About one fourth of a stand was secured in the good pasture area, but in the poor pasture disking was slightly more successful, due to a better seed bed being prepared.

One plot in each area was seeded in mid-December and one about March 25, without any working of the soil. Only a few stray plants of sweet clover resulted. (Purnell Fund.)

Variety Tests of Legumes

A half acre of the Heater lot on the University farm was laid off by F. S. Prince into eightieth-acre plots in 1926 and seeded to different varieties and strains of alfalfa and sweet clover and to red clover and sweet clover from different sources.

The plots were observed in 1927 for thickness of stand, winter killing, and general habits of growth.

The alfalfa varieties rank for 1927 in the following order: Ontario Variegated, Cossack, Hardigan, Grimm. Grimm seemed to be the only variety which suffered from winter killing, and that only slightly.

Sweet clover seedings were made as follows: Yellow and White Blossom from Canada, White Blossom from Michigan, Ohio, and Alabama.

There was no winter-killing in any of the sweet clover plots; the only difference observed was that the farther north the source of the seed, the earlier was the maturity. As between Canadian White Blossom and Alabama White Blossom sweet clover, this difference appeared to be about ten days, a variation that has held throughout the season.

Plots were sowed with red clover seed from Poland, Germany, Minnesota, Chile, Michigan, Hungary and France, obtained from the United States Department of Agriculture. The only strain which suffered from winter killing was that from Poland.

All the plots in this test were in duplicate, limed at the rate of two and one-half tons per acre, and fertilized with 500 pounds of acid phosphate per acre. (Hatch Fund.)

EFFECT OF SICCATIVES ON VITALITY OF SEEDS

If potato seed is cut in advance of planting and sacked, the stand obtained will be better if the pieces are freely dusted with sulphur before being bagged, finds O. Butler.

Tubers of certified seed were carefully halved along the major axis and each half was cut into seed pieces. One lot was dusted with sulphur and sacked, and the other lot was sacked without treatment. Both lots were placed in storage in a dark cellar at 15.9° C. for four days and planted. The seed that was sulphured produced 2.9 per cent weak hills, the non-treated seed 4.48 per cent. (State Fund.)

THE COST OF PRODUCING POTATOES

Great variations in the labor cost of producing potatoes in New Hampshire are indicated in the figures for the first year in this study conducted by M. F. Abell.

Growers handling over eleven acres, for example, were found raising the crop up to market time at a labor cost of 71.6 hours per acre, whereas producers with less than three acres in the same section of the state required 131 hours.

Similar variations were found in comparing farmers who used machines for planting and digging with those who performed these operations by hand.

Potato studies show that machine work is badly needed to reduce cost of production on many New Hampshire farms.

During the fall of 1926 survey records to determine costs and methods of raising potatoes in New Hampshire were obtained on 191 farms. So far as possible, all farms in the state raising two acres or more were included.

The labor required to care for the crop as well as the material used and all miscellaneous costs indicated an average cost of $164.85 per acre. The actual labor rate on each farm was used to compute labor costs. This figure averaged 40 cents. Horse labor was charged at half this amount. The use of machinery was put at 7 cents per hour, except tractor and truck.

Labor requirements varied little in the different sections of the state. Greater differences occurred within the same potato growing section because of variations in area grown.

On the smaller areas most of the work was done by hand, and on the larger areas by machinery. In Coos County, where machinery was invariably used in planting and care, digging was quite largely done by hand. Of the group of 64 farms in that county but 10 had diggers. These dug potatoes with a labor cost of 46.8 man hours per acre, while those digging by hand required 62.9 hours. The total human labor cost, where hand methods were employed, averaged 125 hours, 138 hours, and 130 hours in southeastern, central and northern New Hampshire respectively. Where machine methods were used, the averages ran 84 hours, 89 hours and 100 hours respectively.

The opportunity to save labor by using machinery is greatest in the planting and digging operations. These savings are most apparent on the larger areas, where the machines may be used economically.

The northern area is using markedly less good seed and spraying less frequently. The difference in yield of 40 bushels per acre when the crop is sprayed three times or more, even considering that the number of times sprayed is not a true measure of thoroughness, indicates the value of the practice.

With the small number of cases in which dusting was practised no material differences in yield appeared as compared with wet Bordeaux sprays. (Purnell Fund.)

STUDIES OF POTATO LEAF-ROLL

Difficulties in the way of maintaining potato seed stock in southern New Hampshire have been found by the Experiment Station to be due probably to the spread of leaf-roll. Studies of this disease have been continued in the plots in East Kingston with a view to determining the reason why this disease should be more marked than in the northern sections and whether there is any method of controlling it. Up to the present time it has been necessary to discourage the growers in the southern part of the state from selecting their own home-grown seed.

Comparisons have been made since 1922 with seed grown at East Kingston and seed from the stock as grown at its original source in Maine. Beginning in 1926 it was found that the seed grown in East Kingston and harvested 90 days after planting, which should have given promising results, produced stock so badly affected with leaf-roll as to make it unfit for further use as seed. At the same time stock grown continually at the same source in Maine showed a high per cent of leaf-roll beginning with 1925, but did not increase materially in 1926. In 1926 the per cent of leaf-roll in the Maine fields was 12 per cent as compared with 39 per cent at East Kingston.

During the course of the above experiment it was found that the mean temperature at East Kingston from May when potatoes were ordinarily planted until August when the 90-day stock was harvested and from late June until the middle of September was approximately the same. It was thought, therefore, that immature seed of satisfactory quality might be produced by planting at the end of June and harvesting in late September, and in 1925 an experiment was made with this end in view. Seed from northern New Hampshire stock was planted on June 23 and harvested September 21. The disease record for the plants was: mosaic, 0.78 per cent; leaf-roll, 1.17 per cent. In 1926 the stock from the late planted seed showed 42.9 per cent net necrosis, whereas that from the early planted seed showed between 3.2 and 4.6 per cent.

The removal of tubers affected by net necrosis prior to planting proved a small help, but was by no means sufficient to control the disease.

Studies of the vigor and method of sprouting of the potato indicate that a very large per cent of leaf-roll tubers may be recognized by the way in which a tuber sprouts. (Purnell Fund.)

CONTROL OF POTATO TIP-BURN

The comparison of spraying versus dusting potatoes conducted by O. Butler showed conspicuously greater resistance to tip-burn on the sprayed plots. An 8–4–50 Bordeaux mixture was applied every fourteen days, or five times during the season, while dust was applied every seven days, *i.e.*, nine times for the season.

Tip-burn developed quite severely during the summer, and the non-treated and dusted plots were nearly dead on September 1, whereas the plants in the sprayed plot were still green. (State Fund.)

EUROPEAN CORN BORER NOT YET A MENACE

For the fourth year careful studies have been made of the European corn borer under New Hampshire conditions.

The species entered the growing season of 1927, however, without visible increase in numbers over those of the preceding three years. Studies were begun and carried out by W. C. O'Kane in more than twenty localities, including areas in which the insect had been present for at least three consecutive seasons. In none of these was the pest found in sufficient numbers to amount to anything. Only by extended search could any individuals be discovered. Apparently, the density of population of this insect under New Hampshire conditions remains stationary.

While this makes the work under this project difficult, and some of it impossible, it has an important bearing on the data published in Technical Bulletin No. 33, which reported on the first three years' work. The suggestion was then offered that the European corn borer, as observed in New Hampshire, appeared, up to date, to be self-limiting in abundance, possibly because of a marked inherent tendency to go through two generations instead of one. Survival over the winter rested largely with such individuals as were content with one generation. Individuals representing the two-generation phase seemed unable to reach sufficient development to hibernate successfully. A majority of the individuals attempted a second generation, however, in spite of an unfavorable length of summer season.

The studies of this year, although seriously handicapped by lack of material to work with, seem to support the suggestion offered in Technical Bulletin No. 33. If so, they are significant and may indicate that under normal conditions the European corn borer will fail to become destructive in most of New Hampshire. (Adams Fund.)

EFFECT OF FERTILIZER ON SWEET CORN

A series of nine plots has been studied for two years by F. S. Prince and J. R. Hepler in which varying amounts of fertilizer have been used for sweet corn. These plots, which are run in quadruplicate with eight check plots, showed the following average yields of ears in pounds per acre for the two years 1926 and 1927: Plot 1 (15 loads manure), 5,576 pounds; Plot 2 (30 loads manure), 6,590 pounds; Plot 3 (15 loads manure, 400 acid phosphate), 5,995 pounds; Plot 4 (15 loads manure, 800 pounds acid phosphate), 6,105 pounds; Plot 5 (15 loads manure, 400 pounds 3–10–4 fertilizer), 6,154 pounds; Plot 6 (15 loads manure, 800 pounds 3–10–4 fertilizer), 6,235 pounds; Plot 7 (800 pounds 3–10–4 fertilizer), 5,108 pounds; Plot 8 (15 loads manure, 400 pounds 5–8–7 fertilizer), 5,920 pounds, Plot 9 (15 loads manure, 800 pounds 5–8–7 fertilizer), 6,290 pounds.

The yields for 1927 were much lower than in 1926, due to the lack of native fertility of the soil utilized and also to a very cool growing season.

The effects of manure were more apparent in 1927 than in 1926, those plots receiving 30 loads of manure being the heaviest yielders in 1927, while the previous year this was not the case. The 400 pounds acid phosphate treatment is the only fertilizer which has thus far paid for its original cost. (Hatch Fund.)

EFFECT OF FERTILIZER ON STRAWBERRIES

What effect does the continued previous application of fertilizer to land have on strawberry production? This question was a subject of study last year in vegetable garden plots which for eight years have been handled with the following applications: Plot 1, 32 tons manure; Plot 2, 24 tons manure, 150 pounds tankage, 100 pounds sodium nitrate, 600 pounds acid phosphate, 150 pounds muriate of potash; Plot 3, green manure, 250 pounds tankage, 160 pounds nitrate of soda, 500 pounds acid phosphate, 300 pounds muriate of potash; Plot 4, 16 tons manure, same chemicals as Plot 3; Plot 5, check; Plot 6, 8 tons manure and same chemicals as Plot 3; Plot 7, green manure.

Prior to 1926 these plots had been used for the production of annual truck crops. The fertilizers are spread broadcast and worked into the soil before the crop is planted; and one half of each plot is limed every other season. The sandy loam soil of these plots originally contained only a small amount of organic matter.

The field was set to Howard 17 strawberry plants in the spring of 1926. The most noticeable result from the fertilizers was a high mortality of the plants set in those plots receiving chemicals. The relative stands in Plots 2, 4, and 6, seem to indicate that manure to a certain extent counteracted the killing effect of the chemical fertilizers. Manure enormously increased the production of new runner plants; Plot 1 produced 28.7 more new plants per plant set than the check, or more than twice as many. Ordinarily one would expect a proportionately greater increase from a light application of stable manure than from additional amounts. In this case Plots 4 and 6, which received a heavy application of chemicals in addition to the manure, produced fewer runner plants than the number which would be proportional to the manure applied. This indicates that the number of new plants is less than would have been obtained had no chemical been used.

This difference was proportionately as great early in the season as in October, indicating that the effect of chemicals on runner growth was probably due mostly to its early effect in the season on the plants set.

The yield was high and was directly proportional to the number of plants produced. In Plot 1 the plants formed such a wide dense matted row that picking was difficult.

On June 28, when 54.9 per cent of the crop had been harvested, the variation of any single plot was not more than 3.5 per cent from the average, and the variations were not consistent with the treatments or with growth. In this experiment fertilizers did not affect the time of ripening.

A comparison of the limed and unlimed half of these plots shows little or no effect due to lime. Of the plants surviving, 50.4 per cent were in the unlimed half, and the fruit produced was 49.5 per cent of the total. There were some rather wide variations in individual plots both in number of plants and in yield, but they appear to be simply chance fluctuations rather than due to any effect of the lime. (Hatch Fund.)

Effect of Acid Phosphate

The fact that acid phosphate has previously been found to stimulate to a marked degree the early growth of tomato plants led to a study of this fertilizer on strawberries by J. R. Hepler. A series of eight treatments was repeated with four different plots to each treatment; 20 tons of manure per acre were applied to each plot, with additional applications of acid phosphate in varying amounts, also muriate of potash and gypsum; to one series 40 tons of manure per acre were applied. Commercial fertilizer was distributed after the plants were set and was put between the rows so there was very little burning. A count of the runners and runner plants originating from twelve typical mother plants from each plot was taken at intervals from July 6 to August 18; from the results it was clear that the phosphorus had no pronounced effect on vegetative growth. Those plots to which 40 tons of manure per acre had been applied for seven seasons gave a marked increase, 30 per cent, over those receiving only 20 tons per acre per year. Plant production was low on the potash plots.

USE OF FERTILIZER ON CABBAGE

The value of applications of manure and fertilizer in cabbage production was shown in a series of plots in an experiment conducted by J. R. Hepler. One-half of the land was fertilized with stable manure at the rate of 20 tons per acre. Eleven different fertilizer treatments were used. Seven contained nitrogen in an amount equivalent to that applied in ten tons of stable manure, the treatment known as the check. In addition there were two acid phosphate and one muriate of potash series.

Notwithstanding the fact that the season was very wet and yields consequently low and variable, it was evident that the plots receiving inorganic forms of nitrogen or commercial fertilizer almost invariably outyielded the extra-manure plots in the manured half. Where no manure was used, except on the check plots, the manure gave more pronounced results.

Except in one instance the yields of the 5–8–7 plots were high. The nitrate of soda plots were consistently high, while tankage yields were low. (Hatch Fund.)

STALK BORER STUDIED

A study of the life history of the stalk borer, an insect often confused with the European corn borer, was completed this year by P. R. Lowry. Though not a pest of major importance, the stalk borer annually causes considerable loss in vegetable and flower gardens. Infestation may be prevented by plowing or closely mowing grassland or weed areas around cultivated fields and gardens, it was found, from about the middle of August to the first week in September, thus preventing egglaying in these areas. Mowing infested weeds or grasses while the larvae are still in the active feeding stage is more likely to increase the infestation in cultivated crops. Burning weeds and grasslands from November to April will destroy the eggs. Especially prized plants may be protected by collars with a band of tanglefoot around the outside.

Further details in the studies of this insect have been published in a report of the project in Technical Bulletin No. 34, "The Stalk Borer." (Hatch Fund.)

THE WHITE MOUNTAIN HOTEL MARKET

Previous studies by the experiment station have shown that large amounts of fresh vegetables and dressed poultry are shipped to the hotels in the White Mountains from outside the state. In order to determine whether this demand may be met to advantage by New Hampshire growers, special investigations were started during the past year.

Vegetables

In carrying on this study, personal visits were made by E. H. Rinear and J. R. Hepler to ten representative hotels. Data were gathered from the stewards regarding the class, variety and quality of vegetables desired. The main objections to buying locally were found to be: (1) the vegetables are not graded uniformly; (2) they are not packaged properly; (3) they are not grown in sufficient volume to supply their needs regularly.

Further information was obtained from local gardeners regarding their growing problems and the varieties best suited to their conditions.

The vegetables grown are usually of the salad type and those that lose quality in shipment. The market is in July and August, which means that

Boxes of fancy tomatoes packed for shipment to White Mountain hotels.

it is late for the early cool season crops and too early for tomatoes and other warm season ones.

The vegetables most in demand are: green string beans, peas, beets, carrots, early cabbage, cauliflower, cucumbers, tomatoes, lettuce, parsley, spinach, chard, New Zealand spinach, turnips and radishes. Asparagus would sell well, but the season is too late for it. It is doubtful if such crops as celery, peppers, melons and lima beans can be grown locally to advantage.

The season is short for many crops and frame culture is necessary for the earliest tomatoes and cucumbers. Most of the other crops must be started under glass, so as to mature them for the early season.

The chief problems of culture are as follows: (1) production of strains better suited to local conditions (this is particularly true of head lettuce, and means seed growing and seed selection); (2) better methods of fertilization and culture to get vegetables earlier and cheaper; (3) the control of certain insects and pests, especially mildew on peas and tip-burn on lettuce; (4) the introduction of other early crops such as endive, Chinese cabbage, kohl rabi.

Because the growing season in the mountain section is short, there is the possibility of gardeners farther south supplying the hotel trade. In testing out this possibility, the co-operation was secured of W. P. Tuttle, a commercial gardener of Dover, who supplied several boxes of tomatoes for trial shipment. These tomatoes were uniform in size and free from blemishes. All were wrapped and packed in standard Boston boxes. One steward was so well pleased that he allowed 24 cents a pound for them, which was the price for hothouse tomatoes.

The preliminary work done on this project during the past season is encouraging although not conclusive. The attitude of the hotel managers and stewards is favorable toward future development. They praised the excellent quality of vegetables supplied by a few growers who are also giving dependable service. There is a demand for further experimentation and development of varieties adapted to the climatic conditions.

The Poultry Demand

In studying the poultry demand, hotel managers and stewards were visited by E. H. Rinear. Definite information was obtained regarding requirements, both as to total amount of each class of poultry used and as to the size and quality desired.

The demand for dressed poultry by the White Mountain hotels was found to be for birds of high quality, of uniform quality and weight packed in standard boxes, and for a dependable supply service.

In order to test out the possibility of supply from sources within the state, arrangements were made with three hotels to receive trial shipments of dressed broilers. The broilers were supplied by R. B. Thurrell of East Wolfeboro. A. W. Lohman of the Poultry Department had charge of the dressing and packing. All of the broilers were full-feathered and well-meated birds, weighing around 2¼ pounds alive. After dressing, wrapping heads and packing one dozen broilers in a box, the net weight varied from 22¾ pounds to 23¾ pounds per box. These boxes were placed immediately in a refrigerator and held at approximately 35° until thoroughly chilled.

The broilers were inspected on arrival by the stewards. Two shipments gave complete satisfaction. One steward volunteered to pay two cents premium per pound over the Boston market if he could get this quality of broilers regularly throughout the season.

From the information gleaned thus far, it seems that there is a desire on the part of the managers and stewards of the White Mountain hotels to purchase poultry from nearby sources. The trial shipments have shown that New Hampshire has broilers of high quality. Before recommendations can be made regarding the possibilities for or against an assembling plant on a small or large scale, more data will have to be had on the costs of operating such plants. (Purnell Fund.)

STORAGE OF CABBAGE

Cabbage was stored by J. R. Hepler in six pits to determine the effect of varying conditions upon the temperature maintained and the keeping quality of the cabbage.

The piles were pyramidal in shape, built up from a depth of four or six heads at the edge of the pile, according to the quantity stored. The roots were cut off, but most of the outside leaves were allowed to remain. The cabbage was covered with three inches of hay and four to eight inches of soil with another layer of hay on the outside. The plan was to cover three of the pits with four inches of soil and three with eight inches, but the depth of covering varied. Chimneys of drain tile were put on two of the pits to carry off excess heat. The temperatures were taken by means of the electrical resistance thermometers which were placed in the center of each pit of cabbage.

Apparently the most important factor in keeping cabbage in pits is the depth of the covering. If the cabbage is properly insulated with dry hay, four inches of soil would probably be sufficient. In Pits 1 and 3, which were most deeply covered, the temperature went up rapidly; and the cabbage when taken out had started to decay so that the storage loss was heavy. In the other four pits the storage loss was much smaller, the cabbage coming out in fair to good condition. The depth of the pile did not appear to influence results. The chimneys did not have a material effect on pit temperatures. (Hatch Fund.)

FERTILIZER AND LIME ON SPINACH

Lime was found to have a decidedly beneficial effect on the production of spinach in the garden fertility experiment conducted by J. R. Hepler. The garden plots, which have been handled for eight years with various fertilizer treatments, are those which were discussed under the strawberry fertilizer project. After the strawberries were harvested last year, these plots were planted to spinach. Fertilizers were applied after plowing, but before the seed was planted. The system of treatments of the plots has previously been given. Plots 4 and 6, having a combination of manure and commercial fertilizer, produced better results than those plots of manure and commercial fertilizer alone or a combination of more manure and less commercial fertilizer. The beneficial effect of the lime is shown by an increase of 56 per cent in yield. (Hatch Fund.)

HOW MUCH POTASH DO TOMATOES NEED?

Preliminary work by T. G. Phillips and T. O. Smith indicate that tomatoes have a surprisingly low potassium requirement. Plants grown with what is usually considered the normal amount of potash in the nutrient solution did not do as well as those grown with one-tenth that amount. As complete absence of potash as could be secured readily resulted, however, in quite evidently abnormal development.

With soy beans no effect of complete absence of potash could be obtained in the first generation.

The work with tomatoes will be continued and accompanied by chemical analysis of the plants at various stages of development. (Adams Fund.)

CAN BEAN SEED BE PREHEATED WITHOUT DESTROYING GERMINATION?

Studies of bean anthracnose, previously conducted by Stuart Dunn, have shown that while this disease can be controlled by heating bean seed to a proper temperature the process greatly devitalizes the seed. It has been found, however, that preheating seed at a moderate temperature makes a considerable difference in its resistance to the necessary high temperature used later.

The seed was placed in an oven at 45° C. for periods ranging from 8 to 20 days and then transferred to an oven at 95° to 100° for periods ranging from 1 to 8 hours. Germination percentages varied from 92 per cent for the short period to 52 per cent for the longer. (Hatch Fund.)

A STUDY OF ROADSIDE MARKETS

A study of roadside markets in New Hampshire was undertaken during the summer of 1927. A record of the business operations on a large number of roadside stands was taken by the survey method. In addition a small number of stands kept a detailed day-by-day record of sales through the season.

The results of the survey are being tabulated and summarized by M. Gale Eastman. Figures from 102 stands show a total sales of all kinds of $281,000. (Purnell Fund.)

MARKET PRICE OF BROILERS

During the past few years there has been a phenomenal increase in the production of broilers by New Hampshire poultrymen. Prices have varied greatly, and a special study is, therefore, being conducted by the Experiment Station of the relation of broiler receipts to prices on the New York market.

By special arrangement with representatives of the Bureau of Agricultural Economics of the United States Department of Agriculture, data were copied from the books of the principal dealers of the New York market, showing the daily individual receipts, weight, place of origin, kind and price. These have been tabulated from January 1, 1925, to May 15, 1926, and the daily average receipts and prices made up. They indicate that New Hampshire supplies 75 per cent or more of the total express broilers sold during the winter months.

A statistical analysis of these data is being made, but as yet little correlation between the amount of receipts and prices has been found.

In addition a study of the causes of market fluctuations and trade preferences as regards quality and size on the New York market was made by E. H. Rinear. Some of the reasons for daily market fluctuations were found to be: changing weather conditions, varying Hebrew demand, lack of organized means of supplying the market regularly, speculation, and influence of small receivers in misjudging the market.

Arrangements were made last spring to have more data copied from the books of the New York dealers, and data will then be available covering a four-year period preceding May 31, 1927. (Purnell Fund.)

CONTROL OF POULTRY PARALYSIS

Range paralysis of poultry has occurred extensively throughout the New England states and generally over the country as a whole, and has come to be one of the most dreaded diseases of growing chickens throughout the summer and early fall months. Its cause is still a mystery. Following the clue that there is evidence of some relation between paralysis and coccidiosis, E. M. Gildow has continued an investigation during the past year of three special phases of this problem: first, the possibility of producing typical paralysis by infecting birds with coccidiosis; second, the possibility of curing or relieving paralysis in birds already showing symptoms by handling them so as to completely eliminate any coccidia in the system; and third, a study of range methods to determine whether preventing a heavy infestation of coccidiosis will also prevent paralysis.

Evidence of immunity development against coccidiosis on the part of birds that had recovered from paralysis was found. Out of four birds given a severe dose of embryonated coccidia the only bird to survive was one which had previously recovered from paralysis. Birds given a half dose amounting to 2,800 embryonated coccidia survived the test, and only one lost weight. Attempts to introduce "crazy chick symptoms" in chicks by doses of coccidia failed, but it is believed that the number of coccidia present in the suspension was not sufficient.

Of a total of 44 paralytic birds placed in batteries during the year without supplementary treatment, it is significant that 14 have recovered and have started laying without showing evidence of the disease in their external appearance and actions. Of the 30 pullets that died, 20 showed evidence of coccidial forms in the intestinal tract, 5 showed no evidence of such forms, and 5 were not autopsied. No evidence of long round worms or tapeworms was detected; some few cecal worms were found in most of the specimens. Two of five birds which showed no evidence of coccidia were in batteries a long enough period to have eliminated the coccidia that they might have harbored.

It was found that the use of a clean range in itself is not enough to prevent paralysis. Approximately 1,200 pullets were reared during the year on land where chickens had not been grown before, but which was of a low-lying type with some swampy areas; 37 cases of paralysis were reported from this flock. On the other hand, on an old piece of land, which had been used for the last four or five years for a poultry range but which was of a high type, 400 pullets were grown, with only 13 cases of paralysis.

Summing up the best information obtained to date, it is believed that coccidiosis in most instances in New Hampshire is closely associated with paralysis. In all probability, there is a form of paralysis which is not connected with any of the internal parasites of poultry. It is believed that a program to prevent or control coccidial infection is essential, including a range-rotation scheme that will insure a good heavy sod which will be without bare spots.

Tests of iodine vermicide, a preparation which has been found helpful in the control of round worms and tapeworms and the resistant forms of coccidia, indicate that this preparation is without value for the treatment of typical paralysis. (Purnell Fund.)

TESTING PULLETS FOR WHITE DIARRHEA

The question of how early in a pullet's life she will show reactions to the agglutination test for bacillary white diarrhea has an important bearing on the work to eradicate this disease. In order to ascertain the facts in this matter a pen of 125 pullets that had suffered from white diarrhea as chicks was tested by E. M. Gildow at monthly intervals from the fourth month after they were hatched until they were 12 months old. The reactors shown were as follows: 2 at 4 months, 4 at 5 months, 3 at 6 months, 2 at 7 months, 1 at 8 months, 0 at 9 months, 1 at 10 months, 0 at 11 months, 1 at 12 months.

The birds showing reactions were removed after each test; this eliminated as far as possible transmission of the disease from one bird to another. The pullets had started laying at 4½ to 5 months of age.

The data indicate that 11 out of a total of 14 positive reactors were eliminated by the time the birds had been laying as a flock for three months, and it would appear inadvisable to test pullets before this time. (Miscellaneous Income.)

TESTING AND SERVICE WORK

White Diarrhea Testing

In the white diarrhea campaign 70,000 birds were tested during the period of June 1, 1926, to March 10, 1927. Practically 20,000 of these were hens and 50,000 pullets. The percentage of infection in both was 2.1 per cent. A total of 133 different flocks was tested, 45 of which had not been tested the previous year. There are now 56 flocks on the accredited list, containing 45,000 birds.

Post-mortem Examinations

Perhaps nothing can show better the difficulties confronted by the poultrymen of the state than a summary of the diseases found among birds sent in one year's time to the laboratory of the Station.

This report shows that 1,875 specimens were received for post-mortem examination. The principal diagnoses were: white diarrhea, 515; coccidiosis, 364; pneumonia and chilling, 342; paralysis, 145; rickets, 67.

The specimens came from 402 different farms and showed all told 38 different types of ailments.

In addition to this work the pathologists, E. M. Gildow and W. Wisnicky, tested 344 blood samples for contagious abortion which were received from dairymen and veterinarians in the state representing about 20 different herds. (Miscellaneous Income.)

Inspection of Feed Stuffs

In connection with the enforcement of the law regulating the sale of concentrated commercial feeding stuffs, 360 samples of these materials were analyzed for the State Department of Agriculture. About 2,900 individual determinations were made in carrying out these analyses. The results are reported in the annual inspection bulletin.

Fertilizer Inspection

One hundred and twenty-six samples of commercial fertilizers were analyzed for the State Department of Agriculture, involving about 850 individual determinations. The results are being published.

Miscellaneous Analyses

Samples of feeds, fertilizers, soils, peats, leaf molds, lime and wood ashes have been sent in by residents of the state. Of these, 80 have been analyzed involving about 190 individual determinations. Many inquiries not involving analysis have been answered.

Seed Inspection Work

The seed inspection work for the State Department of Agriculture was carried on as usual. During the 1927 season a total of 514 samples of seed were handled by the laboratory. This included 395 collected by the state inspector, 20 referee samples, 58 private samples, and 41 retests.

Other Tests

The regular advance registry tests and potato seed certification work were carried on as usual. (Miscellaneous Income.)

NEW PROJECTS

The foregoing report has dealt with projects which have been conducted to a stage where the results may be considered to have become of some importance. In addition to these projects several others have been started recently which it is believed should produce data of importance during the coming years. Among these new projects are:

Studies in Human Nutrition—Caloric Values of Food

This project, which is a study of the nutritive values of foods sold at institutional and commercial eating places in Durham, is carried out in co-operation with Dr. Francis G. Benedict of the Nutrition Laboratory of the Carnegie Institution, which has furnished the necessary apparatus. Very few data are available on the caloric values of mixed foods, and the oxy-calorimeter furnishes a much simpler means for this determination than does the bomb. Up to the present time, combustion and Kjeldahl determinations have been completed on 200 food samples. (Purnell Fund.)

Modified Sprays for the Codling Moth

For two or three seasons the codling moth has been on the increase in New Hampshire apple orchards. At the same time more drastic restrictions are being established as to permissible residues of spray materials on fruit, especially compounds of arsenate and lead. A project has been started, therefore, looking toward possible modification of the sprays used to control the codling moth, especially those applied after the fruit has set. The schedule of various modified sprays includes reduction of the amount of lead arsenate, substitution of calcium arsenate for lead arsenate, substitution of oil sprays for applications containing arsenic, and reduction in number of sprays applied. (Hatch Fund.)

Impregnated Oils

The increased numbers of browntail moths for several seasons has brought up the question of control of this pest by spraying. Some years ago entomologists recommended application of a poison spray to the foliage about the first week in August, in order to kill the young browntail caterpillars before they had spun their winter webs. Under restrictions now prevailing, as to applications of poison sprays to fruit trees bearing fruit of considerable size, this means of control of the browntail must be discarded if the spray applied is a mineral poison such as an arsenic compound. New developments in spray materials have pointed to possible use of white oils impregnated with organic poisons such as those derived from pyrethrum.

Other insects have been brought under observations, including the Colorado potato beetle, the imported cabbage worm, the squash bug, the tarnished plant bug, and the fall web worm. The percentage of kill secured in each case is relatively high. One interesting result is an indication that the creep of the material as influenced by additions of small amounts of soap, for example, has an important bearing on its toxicity. It is planned to continue these studies in considerable detail. (Hatch Fund.)

Arsenical Residue

Four plots of mature Baldwin trees were sprayed carefully in order to determine the average amount and variability in quantity of arsenical residue which will adhere to the fruits at harvest time under the climatic conditions of southern New Hampshire. This work is being conducted co-operatively by S. R. Shimer and G. F. Potter. (Purnell Fund.)

Apple Storage

A study of storage problems, particularly those of the McIntosh and Baldwin apples, is being conducted by L. P. Latimer.

Experimental work was begun at the end of the Baldwin harvest season. Little can be reported at this time, but it is evident that a study of the changes in the electrical conductivity of the tissue and juice during storage will afford a means of detecting physiological changes incident to the ripening of the fruit and related to its storage life. (Hatch Fund.)

Studies of White Pine Weevil

In the summer and fall of 1926 the life history and habits of the white pine weevil in New Hampshire were given detailed study. This was continued for the season 1927. Several gaps in the known life history were filled. Some parasitic enemies were discovered that had not previously been found in the study of this insect in New Hampshire. Observations were made on the dispersion habits of the adults, especially as these have a bearing on reinfestation of a plantation following control measures. (Purnell Fund.)

CHANGES IN STAFF

E. H. Rinear was appointed assistant agricultural economist February 1, 1927, to pursue marketing investigations; Walter Wisnicky, poultry pathologist, July 1, 1927; A. Gertrude Farr, research assistant in human nutrition, July 1, 1927; H. O. Stuart, assistant in charge of white diarrhea testing, September 5, 1927; E. W. Lang, tester, August 22, 1927; E. J. Rasmussen, graduate assistant in horticulture, October 10, 1927; R. Bissey, graduate assistant in botany, July 1, 1927; F. S. Schlenker, graduate assistant in agricultural chemistry, July 1, 1927.

PUBLICATIONS

The following publications were issued during the year:

Station Bulletin 223—Commercial Apple Industry of New Hampshire.
" " 224—Inspection of Commercial Feeding Stuffs, 1926.
" " 225—Inspection of Commercial Fertilizers, 1926.
" " 226—Results of Seed Tests, 1926.
" " 227—Progress of Agricultural Experiments, 1926.
" " 228—Electricity on New England Farms. A Report of the New Hampshire Project on the Relation of Electricity to Agriculture for the years 1925–1926.

Technical Bulletin 31—Some Wool Characters and Their Inheritance.
" " 32—Black Flies in New Hampshire.
" " 33—The European Corn Borer.
" " 34—The Stalk Borer.

Station Circular 26—Hand Spraying and Hand Dusting Potatoes.

Scientific Contribution 22—A Biochemical Study of the False Blossom Disease of the Cranberry. Journal of Agricultural Research, Vol. 34, No. 1. January 1, 1927.

Scientific Contribution 23—Studies of the Metabolism of Steers: I. The Fasting of Large Ruminants; II. The Basal Metabolism of Steers; III. The Metabolic Stimulus of Food in the Case of Steers. Proceedings of the National Academy of Sciences, Vol. 13, No. 3, March, 1927.

EXPENDITURES OF THE NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDED JUNE 30, 1927

	Hatch Fund	Adams Fund	Purnell Fund	Supplementary*	Total
Salaries	$10,163.05	$12,142.44	$19,817.00	$14,132.89	$56,255.38
Labor	507.84	1,085.60	2,031.29	4,384.85	8,009.58
Stationery and office supplies	170.65	26.16	201.74	250.03	648.58
Scientific supplies, consumable	3.00	203.36	563.23	769.29	1,538.88
Feeding stuffs	None	226.12	110.43	460.85	797.40
Sundry supplies	444.85	149.27	183.53	4,550.17	5,327.82
Fertilizers	91.83	None	290.10	26.25	408.18
Communication service	442.58	1.03	4.88	430.13	878.62
Travel expenses	319.48	124.56	2,035.29	3,064.67	5,544.00
Transportation of things	323.83	74.58	37.59	103.65	539.65
Publications	1,068.02	....	537.26	1,062.08	2,667.36
Heat, light, water power	700.00	.49	None	372.25	1,072.74
Furniture, furnishings, fixtures	136.54	50.48	1,159.62	241.14	1,587.78
Library	368.63	None	19.22	249.30	637.15
Scientific equipment	56.50	133.32	649.56	344.33	1,383.71
Livestock	None	None	19.78	None	19.78
Tools, machinery and appliances	203.20	404.86	910.81	1,615.98	3,134.85
Buildings and land	None	377.73	1,227.67	1,448.08	3,053.48
Contingent expenses	None	None	1.00	43.16	44.16
Total	$15,000.00	$15,000.00	$30,000.00	$33,549.10	$93,549.10

*This fund includes expenditures from the following sources:

State appropriations	$4,500.00
Sales and miscellaneous	29,049.10
	$33,549.10

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION

Staff

EDWARD M. LEWIS, *President.*
J. C. KENDALL, B. S., *Director*
F. W. TAYLOR, B. S. (Agr.), *Agronomist*
W. C. O'KANE, A. M., *Entomologist*
O. R. BUTLER, PH. D., *Botanist*
E. G. RITZMAN, B. S., *Research Professor in Animal Husbandry*
K. W. WOODWARD, A. B., M. F., *Forester*
J. M. FULLER, B. S., *Dairy Husbandman*
A. W. RICHARDSON, B. S., *Poultry Husbandman*
G. F. POTTER, M. S., *Horticulturist*
J. C. MCNUTT, B. S. (Agr.), *Animal Husbandman*
T. G. PHILLIPS, PH. D., *Chemist*
H. C. WOODWORTH, M. S., *Agricultural Economist*
T. O. SMITH, A. B., M. S., *Associate Chemist*
M. G. EASTMAN, M. S., *Associate Agronomist*
W. T. ACKERMAN, M. S., *Specialist in Rural Electricity*
F. S. PRINCE, B. S., *Associate Agronomist*
J. R. HEPLER, M. S., *Assistant in Vegetable Gardening*
P. R. LOWRY, M. S., *Assistant Entomologist*
H. F. DEPEW, B. S., *Assistant Dairy Husbandman*
C. L. STEVENS, B. S., *Assistant Forester*
M. F. ABELL, PH.D., *Assistant Agricultural Economist*
S. R. SHIMER, M. S., *Assistant Chemist*
G. P. PERCIVAL, M. S., *Assistant Chemist*
H. A. ROLLINS, M. S. *Assistant Horticulturist*
L. P. LATIMER, PH.D., *Assistant Horticulturist*
S. DUNN, M. S., *Assistant Botanist*
E. H. RINEAR, M. S., *Specialist in Marketing*
A. D. LITTLEHALE, *Shepherd*
JAMES MACFARLANE, *Florist*
A. GERTRUDE FARR, *Assistant in Nutrition Studies*
L. R. TUCKER, B. S., *Research Assistant in Horticulture*
F. S. SCHLENKER, *Research Assistant in Agricultural Chemistry*
H. O. STUART, B. S., *Poultry Tester*
ELMER W. LANG, B. S., *Assistant Poultry Tester*
R. M. BATCHELDER, *Assistant in Animal Husbandry*

Assistants to the Staff

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W. P. LEWIS, B. L. S., M. A., *Librarian*
RAYMOND C. MAGRATH, *Business Secretary*
BEATRICE M. RICHMOND, *Bookkeeper*
ELIZABETH E. MEHAFFEY, *Assistant Librarian and Mailing Clerk*
CHRISTINA M. COLLINS, *Stenographer*
HELEN M. HILTON, *Stenographer*
MARY E. LAWLESS, *Stenographer*
MURIEL E. MURRAY, *Stenographer*
JEAN EDMUNDSON, *Stenographer*
ELIZABETH ROWE, *Stenographer*
MARGARET SYMES, *Stenographer*
NETTIE E. DURGIN, *Clerk*