A history of the Wisconsin Agricultural Experiment Station. Part I: The directorship of William Arnon Henry from 1880 to 1907. 1935

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A History of the Wisconsin Agricultural Experiment Station

Part 1.

by A.S. Alexander

The Directorship of William Arnon Henry from 1880 to 1907

University of Wisconsin

CONTENTS

Chapter I

Early Days in Wisconsin

Of the territories originally forming the "Old Northwest," and stretching as a wilderness from the Ohio River to the Great Lakes and the valley of the Mississippi, Wisconsin was one of the most noted hunting, trapping, fur trading and fishing areas. There, until about 1830, roamed Indian tribes, a few traders and the hardy frontiersmen who explored the region and sent word back east that settlers well might make homes for themselves by its streams and lakes, on its fertile prairies, and in its great forests of pine and hardwood.

Up to that time the, fur trade had been the predominating interest of the Wisconsin region; but the growing lead mining industry of the Southwestern districts began to overshadow the fur trade, and, in the mining regions, towns and smelting furnaces were rapidly built. The Black Hawk war of 1832 grew out of a dispute over the mineral lands, and not merely settled the Indian question, so far as Wisconsin was concerned, but made the region better known, and gave an appreciable impetus to its growth. A series of Indian treaties in 1829, 1831, and 1833 extinquished the Indian titles and opened up to settlement a vast area of new land. Settlers began to pour in at the close of the Black Hawk war. In 1834, two land offices were opened, and in 1836, 878,014 acres of land had been sold to settlers and speculators. A special census showed a population of more than 11,000 whites, in 1836, when the territory of Wisconsin was established.

The first Territorial Council met in 1836, at Old Belmont, Lafayette County, but in December of that year, despite the keen rivalry of other ~~cities,~~ Centers Madison was selected as the capital.

The movement for the admission of Wisconsin to the Union was earnestly pressed, soon after 1840, and on August 10, 1846 an Enabling Act, introduced in Congress by Morgan L. Martin, the Territorial delegate, was approved by President Polk. Meanwhile the Territorial legislature had passed favorably on the matter, and, in April, the Act was ratified by a popular vote. The first constitution drafted was rejected, April 5, 1847; but a second convention drafted a substitute constitution which was adopted March 13, 1848. This constitution was approved by Congress and signed by the President on May 20, 1848, making Wisconsin a separate state of the Union. On June 7, 1848, the first governor, Nelson Dewey, and other State officers, took the oath of office, as they had been elected the previous May.

Meanwhile, the population of Wisconsin had materially increased. The original 11,000, of 1836, had, by 1846, increased to 155,277, and that total doubled in four years, and almost doubled again in another five years. In the fifteen years between 1840 and 1855, over half a million souls occupied the new lands of Wisconsin, or were born there.

The earliest settlers came largely from New York State, which they left in 1837, on account of a panic. Up to 1850 New York sent Wisconsin six times as many settlers as any other state, or more than one-fifth of its entire population. About the same time, over 11,000 arrived from Ohio, 10,000 from Vermont, over 9,000 from Pennsylvania and some 5,000 from Illinois, with scattering contingents from several other states.

~~There~~ Then, from 1840 to 1850, immigrants began to arrive from Europe. People from famine ravished Ireland led the band. Over 20,000 arriving during the time mentioned, while almost that number of English came in miners from Cornwell and Wales, flocked into the Southwestern lead mining districts. The English were about as numerous as the Irish, while the Welsh numbered 4,300; and the Scots, 3,500. Canadians, largely of British blood, and many of French extraction, also swelled the population of Wisconsin.

During the same period, German settlers had been arriving in even greater numbers, by way of Milwaukee, which had been their chief point of entry since 1839. They numbered over 40,000 up to 1850, and later exceeded all other immigrants. By that date, some 9,000 Norse people had entered the state. The first arrivals, in 1835 and 1836, settling in the Fox River prairie region, while, in 1839, more began farming near Muskego Lake, near Milwaukee, and many more formed the notable Norse settlement around Lake Kosh Konong, in the southwest corner of Jefferson County, which, says Prof. J. F. A. Pyre in his History of Wisconsin University, (1920) was, for a time "the destination of four-fifths of those who emigrated from Norway."

By 1855, some 550,000 people had settled in Wisconsin. Most of the early settlers were men; but in 1850 there were nearly as many women in the state. Families quickly sprang up, some 400,000 children being born in Wisconsin during the next 20 years. In 1850, 40,000 of the settlers were farmers, and many others found employment in the lumber camps and various beginning industries. Settlers of other nationalities had also arrived, including Belgians, Bohemians, Danes, Dutch, Finlanders, Icelanders, ~~and~~ Italians, and others.

In the summer of 1836, Dane County, where later was established the University of Wisconsin, the College of Agriculture and the State Agricultural Experiment Station, had, so far as is known, but five white residents.

These were, according to Thwaites' History; Ebenezer Brigham, the original settler at East Mound; Eben Peck, who lived with Brigham; Berry Haney, a ranchman squatting on the military ~~road~~ oad, at what is now Cross Plains; a Frenchman named Olivier Armel, who maintained a temporary trading shanty in the wooded isthmus between Lake Monona and Lake Mendota; and Abel Rasdall, an Indian trader, whose cabin stood on the eastern shore of Lake Kegonsa. A French half-breed trader, named Michel St. Cyr. also lived on the banks of Lake Mendota, three-fourths of a mile north of Pheasant Branch.

That Dane County had been poorly regarded by pioneer explorers seems evident from a remark made by J. A. Wakefield in his History of the Black Hawk War, published in 1834. Regarding the Four Lakes County, where Madison, the State Capital is now located, he said, "If these lakes were anywhere else except in the county they are, they would be considered among the wonders of the world. But the country they are situated in is not fit for any civilized nation of people to inhabit. It appears that the Almightly intended it for the children of the forest." Yet Dane County was destined to become the banner agricultural region of Wisconsin, and the seat of her halls of legislation and learning. As early as 1850, a sale of 5,320 acres of school and University lands in Dane County brought $29,280.03 into the common school fund.

In 1860 the population had increased to 775,881 and in 1870 to 1,054,870. By the state census of 1905 it was 2,228,949 and that of 1920 showed a total of 2,632,067, with a rural population of 1,387,499 on farms.

In 1900, in addition to the nationalities already mentioned, there were 8,372 Indians, 2,543 negroes, 212 Chinese and 5 Japanese in the State. The census of 1920 showed that there were over 10,300 Indians upon the reservations and occupying private property in the state.

The census of 1930 showed a total population of 2,939,006 in Wisconsin, with 873,008 people residing on farms.

Chapter II.

Beginnings in Agricultural Education

When Wisconsin became a Territory in 1836, its legislature, in its first session, passed an act to create a university supported by the Territory; but except for the naming of a board of trustees the plan was never put into operation. A similar act for the establishment of a university at Green Bay had no more result. In 1838, a university of the Territory of Wisconsin was created by an act of the Territorial legislature and it was endowed with two townships of land. This was the germ of the great state University of today.

When Wisconsin was admitted to the Union, under act of Congress, Section 6 of Article X of the State Constitution provided for the establishment of the University of Wisconsin.

On July 26, 1848, the State University was incorporated with four Departments, viz.: (1) Science, Literature, and Arts, (2) Law, (3) Medicine, (4) Theory and Practice of Elementary Education. A board of regents, as a governing body, was also chosen by the legislature.

In September 1849 John H. Lathrop (1799-1866) was made Chancellor of the University of Wisconsin. He had been president of the University of Missouri from 1840, until he came to Wisconsin. He was inaugurated in 1850. In 1858 he left Wisconsin and in 1859 became president of the University of Indiana, but in 1860 returned to the Missouri institution.

In one of his early communications to the board of Regents Chancellor Lathrop wrote, relative to the four departments established at the University: "To this, I am satisfied, we must add a fifth, namely, a school of the application of science to agriculture and the useful arts."

Under Chancellor Lathrop's administration the University progressed. In 1850, North Hall was erected and for four years was the sole University building. South Hall was ready for occupancy in 1855 and Old Main Hall was completed in the summer of 1859.

Agricultural Education Advocated

People interested in agriculture had long been urging the establishment of an agricultural school. Wisconsin had, in 1848, established an excellent free public school system, for country district and city school instruction, but agricultural education had, as yet, not received much attention. There was need of the training of teachers for the country and city schools, and also of industrial education. Agricultural societies were springing up, and their members began clamoring for instruction in scientific agriculture. But there was great diversity of opinion in the State regarding the advisability and importance of "book learning" for farmers. The ideas of many different nationalities on the subject were not yet homogonized , and as virgin soil was being farmed, few problems relative to production seemed necessary of solving their soil-robbing began to tell in diminished crops and a remedy had to be found. This emphasized the need of agricultural education and increased the demands for facilities in that direction.

In Michigan, a similar campaign had been waged, and it won out sooner there than in Wisconsin. Michigan's new Constitution, of 1850, demanded creation of a state agricultural college and her legislature petitioned Congress for a grant of land to aid the project. The plea was denied, but the Michigan legislature of 1853 set aside a part of the saline lands which the state had received for general purposes, and added an appropriation of $40,000 and in 1857 opened the first College of Agriculture in America.

By an act of the legislature approved February 9, 1853 the Wisconsin State Agricultural Society which had been organized in March, 1851, was incorporated, its object being to promote and improve the condition of agriculture, horticulture, and the mechanical, manufacturing and household arts. The new society did much to promote agricultural knowledge by its fairs and especially by the convention it held annually at the State Capital. That meeting was largely participated in by men representing the educational and industrial interests of Wisconsin and they used their influence in favor of higher education in agriculture.

In Wisconsin the creation of an agricultural department of the University continued to be urged. In 1854, the Assembly Committee on Agriculture and Manufactures at the request of the State Board of Agriculture and Governor Randall, made a report to That body strongly urging that the state "swamp lands" be turned over in a trust to the University funds for the creation of such a department "Let it be known" wrote the Chairman, Abner Mitchell, of Green County "that there is one spot upon the broad bosom of our State, where the farm boy can burst his chrysalis of gloom, and walk forth in the clear blaze of rural light, with all its laws and conditions in view, and the result will show in favor of what profession aspiring talent will manifest **** Let this be done and your Committee will guarantee that there will be much less discrimination against rural pursuits by youth of talent and energy."

Agricultural Teaching Begun

The committee report failed to convince the legislature, but, in May 1854, the regents of the University engaged Dr.S. P. Lathrop M.D. of Beloit to be professor of chemistry and natural history, and he continued to discharge his duties until his death on Christmas Day of the following December.

Dr. Lathrop's chair was intended to be the nucleus of an agricultural department, and in the report of the board of regents of the University, for 1854, they promised to select a successor in July. "It will be a part of the plan of the department", they said,"to offer yearly instruction in agriculture, classes in chemistry and its applications."

Dr. Lathrop's successor was Dr. E. S. Carr, and in the regents report, of 1855, it is stated that he would lecture on agricultural chemistry and the applications of science to the useful arts. His course of instruction was expressly designed for the young farmers and artisans of the State, and it was hoped that many would avail themselves of the opportunity afforded to carry the instructions of the laboratory into the industrial operations of the community at large. It was expected that each pupil of the new department would become the instructor of his vicinage, and it was considered especially desirable that the teachers of the district schools should be well versed in natural science and its applications. The University proposed to open the way to this very valuable result, by arranging the agricultural and the teachers classes at the same time. "We have here" says Thwaites in his "History of the University of Wisconsin", "the germ of the area from which sprang the farmers' institutes of the succeeding generation."

Agricultural Lands Purchased

In 1856 a bill was introduced in the assembly to reorganize the University and endow one of its departments with the agricultural college land. This bill was concurred in by the Senate and being signed by Governor Fairchild became a law on April 12, 1866. It was hoped that under this act it would be possible to establish the College of Agriculture before the funds from its land grant became available and without any considerable investment in buildings or duplicating instruction in those fundamental branches of education already being taught in the University.

In 1866 the board of regents of the University purchased the greater part of the lands composing the present Agricultural Experiment farm.

The University Reorganized

That year also saw ~~was~~ the reorganization and real commencement of the University as it is known today. Purchase of the experimental farm secured the retention in Madison of the College of Agriculture which had been endowed by the Morrill Act of 1862.

The reorganization of the University was necessitated and hastened by the fact that the five year period within which the State might take and claim the benefit of the Morrill Act had about run out. By the provisions of this Act the State was granted 240,000 acres of public land, 30,000 acres for each Senator and Representative in Congress, for the endowment of at least one college where the leading object should be, without excluding other scientific and classical studies and including military tactics, to teach such branches of learning as are related to agriculture and the mechanical arts, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life.

Establishing the Agricultural College

A contest arose between rival cities to secure establishment of the Agricultural College and led the officials of Dane County to contribute a part of the expense of its foundation at Madison. A special Act had transferred to the general treasury the fund for the administration of the University and it required the board of regents to make arrangements for securing, without expense to the State, or to the funds of the University, suitable lands in the immediate vicinity of the University, not less than 200 acres, including the University grounds, for an experiment farm. To effect this the law authorized the supervisors of Dane County to issue 20-year bonds for the amount of $40,000, the proceeds of their sale to be delivered to the board of regents and by them applied to the purchase and improvement of the proposed experiment farm.

Funds for the College

Concluding that it would be greatly to the interest of Dane County to secure the location of the College of Agriculture at Madison, the county officers promptly issued the bonds and they were taken up by the University Fund. Therewith the board of regents, in 1866, bought 195 acres adjoining the original University campus to the west, for $27,058.

Immediately after the terms of the Morrill Act of 1862 were accepted by the State, the public lands for the endowment of the College of Agriculture had been located in a tier of counties in the North Central region of Wisconsin, with Marathon County as a center. These lands gradually were sold. By 1874, the first year of President Bascom's administration the fund from these sales amounted to $236,000. Thereafter, according to Prof. Pyre, the best of the lands having been sold, the disposal of the remainder was a tedious process and somewhat insignificant, for, by this time a new source of income had been found. The legislature of 1867 appropriated to the University the sum of $7,303.76 per annum for a period of 10 years. The next legislature appropriated $50,000 for the erection of Ladies' Hall. Prosperity followed in due course.

Prof. Daniell's Appointed

On June 22, 1867, Dr. Paul A. Chadbourne was unanimously elected President of the University, coming directly from the presidency of the State Agricultural College at Amherst, Masschusetts.

Naturally, he was favorable to the teaching of agriculture as a part of the instruction given at the University and on February 14, 1868, under his leadership, William W. Daniells M.S. of the chemistry department of Lawrence Scientific School, at Harvard University was elected professor of agriculture and Addison E. Verrell professor of comparative anatomy and entomology. Few men were available at that time who possessed the necessary training and experience to fit them as an efficient teacher of agriculture science, but Prof. Daniell's proved well qualified.

Little interest was taken in the new agricultural course, although it had liberally advertised and recommended in the University catalogue. Indeed, a full outline of a systematic course of study leading to a special degree in agriculture was offered, but students were few and far between. As late as 1880 the board of visitors expressed disappointment in the condition and deplored the lack of students. There is the record, however, of the graduation of one student, William West Brown, of Merton, Waukesha County, in 1878.

The elective courses advertised during the period from 1868 to 1873 included the following subjects: Practical agriculture and botany, examination of soils, horticulture, history of useful plants, entomology and natural history of domestic animals; forestry and climatology.

"Few of these courses" says Prof. Pyre, "were actually offered or taken, and mention of this was soon omitted." Agriculture and meteorology, previously elective, was prescribed as a five hour study for sophomores, in the College of Arts, for one term in 1872 - 1873, and agriculture as a 2-hour study the following year. Thereafter, such studies, even as options, were relegated to the junior and senior years of the special agricultural course in which there was but one student in 10 years.

"The failure of agriculture as a college course, during these years could be attributed to lack of general interest on the part of the farmers of the state, and to a somewhat unattractive presentation of the subject. However, Professor Daniells was highly regarded as one of a group of scholars who placed the teaching of science in the University upon a solid basis. Prof. Pyre says that Professor Daniells was a force in the University in those formative days, and that he belonged to that positive and constructive group in the faculty who worked earnestly and intelligently toward better and better things.

Dr. John E. Davies, who assisted Professor Daniells in the teaching of agricultural subjects, also failed to attract students and their energies, eventually, were largely devoted to the general science teaching, Daniells specializing in chemistry and Davies in physics.

Dr. Bascom's Presidency

Dr. John Bascom, of Williams College, who has been rightly called "a great man and preeminately a great teacher" was elected President of the University. Outgoing President Chadbourne had recommended Dr. Bascom who assumed his duties as president early in the spring of 1874 and continued in that position until 1887.

With the advent of President Bascom the University came into possession of the "full vigor of early manhood." Funds for its conduct were, however, woefully scarce. The annual income, in 1875, amounted to but $32,000, or thereabouts, while the necessary expenses of the past year had been nearly $60,000. In 1876 the legislature came to the rescue by appropriating to the University fund income, in lieu of former levies, an annual tax of one-tenth of a mill om each dollar of the assessed valuations of the taxable property of the state. The first levy under the act, in 1877, brought the University $42,359.62. In 1900, the same tax, under an unusually low valuation produced just $60,000. In 1877 Science Hall was opened and in 1878 Washburn Observatory was completed. It was enlarged the following year.

And the fact that he had been an instructor in agriculture at Michigan Agricultural College, where he had graduated, helped him in his class room. He went vigorously to work in the summer of 1868 getting the new lands in shape for experimental use.

Greatly to the credit of Professor Henry, President Bascom's report of 1881 said: "The agricultural department is, for the first time, beginning to ~~stride~~ take root a little, and to promise some growth." Hitherto, it had been considered of little ~~movement~~ moment, but Professor Henry earnestly set himself the uphill task of bringing the College of Agriculture to the front and was destined, in later years, to make his agricultural department "one of the most important in the University and to win for its staff a reputation, in some respects, second to none in the United States." (Thwaites)

Chapter III.

Establishment of the Agricultural Experiment Station in 1883

The Agricultural Experiment Station of the University of Wisconsin was established in June 1883 under provisions of Chapter 300 of the laws of that year. In his message of 1883 Governor Jeremiah M. Rusk had recommended an appropriation of $6,000 for the purpose of establishing an experiment station on the University farm and passage of the Act resulted. It was approved April 2, 1883. In accordance this act, the Board of Regents organized the Station, with W. A. Henry, professor of agriculture, H. P. Armsby, professor of agricultural chemistry, and William Trelease, professor of botany and horticulture. The establishment of the Station was accomplished in response to "the popular sentiment of the State strongly demanding that the growing necessity for increased educational facilities for instruction in the agricultural arts shall be supplied."

Chapter 320, of the laws of 1883, approved April 3, 1883, further provided that the State printer annually should print 12,000 copies of the annual report of the department of agriculture of the State University; the number of pages of each not to exceed 100, and distribution of the reports to be made according to directions set forth in the law.

The Agricultural Experiment Station thus provided for began work October 1, 1883, its purpose being "to advance knowledge of practical and scientific agriculture, with a view to more fully develop the great agricultural resources of Wisconsin." The income of the Experiment Station was from three to four thousand dollars a year, besides the salaries of the three professors mentioned.

Preparations for Experimentation

For 17 years prior to the establishment of the Experiment Station, the University had maintained a farm for instructional and experimental purposes.

In 1866 Governor Fairchild had signed an act for the reorganization of the University. Where upon, the board of regents bought for $27058, 195 acres of land adjoining the University Campus on the west, which formed the nucleus of the present Experiment Station farm. The purchase of this land secured the retention in Madison of the College of Agriculture which had been endowed by the Morrill Act of 1862.

The Work of Professor Daniells

On June 22, 1867, Paul A Chadbourne M.D. was elected President of the University, after having acted as president of the State Agricultural College, Amherst, Massachusetts. Being favorable to the teaching of agriculture, as a part of the University curriculum, he appointed on February 14, 1868 as professor of that subject, William Willard Daniells M.S. of the Chemistry department of Lawrence Scientific School at Harvard University.

Prof. Daniells proved well qualified for his work, as he had been an instructor in agriculture in Michigan Agricultural College of which institution he was a graduate.

In the summer of 1868 he worked vigorously to ~~put~~ get the newly bought farm lands in condition for agricultural experiment use. They had to be broken, subdued and cleared of trees and stumps. One of the ~~furst~~ first accomplishments under his guidance was the setting out of a vineyard on the South slope of Observatory Hill, and the preparation of some 10 acres, on the northern slope, for an apple orchard. There a commodious farm barn and a modest farm house were built, drives laid out and graded, and many evergreens planted.

Meanwhile, the land for experiments - all purposes, west of University Hill, had been prepared and divided into acre lots.

The Pioneer Experiments

As soon as possible, some of these plots were planted with farm crops. Four of them were devoted to corn-growing, and eight of them to potato culture, the first year. Some worth while facts were learned by these initial experiments, and others followed to determine the varieties of grain best adapted for Wisconsin soil and climatic conditions. Even in those early experiments, the value of fertilizers was studied, while attention was also paid to the destruction of plant pests. The advantages of different methods of planting and cultivating crops and the comparative profits to be had from various grains. Gradually, the experiments broadened in scope, and became more and more important.

That Prof Daniells perfectly understood the ~~due~~ dire need of improved methods of farming, is clearly shown by his writings, and he set himself the task of initiating more scientific and practical system of agriculture in the state.

"The early agriculture of Wisconsin was mere land-skimming" he said, "good cultivation was never thought of. the same land was planted successively to one crop, as long as it yielded enough to pay for cultivation. Farming as then practiced was a quick method of land exhaustion. It was always taking out of the purse and never putting in. No attention was paid to sustaining the soil's fertility.

The only aim was to secure the largest crop for the smallest outlay of capital, without regard to the future. To the first farmers of the State, poor farming was the only profitable farming, and consequently the only good farming an economic paradox from which there was no escape."

The most notable result of Professor Daniells experiment work was perhaps the growing and dissemination of a new variety of barley which had been brought to Germany, from the mountains of Manchuria, Asia, and placed with the director of the German Emperor's garden at Sans Souci. Some kernels of this barley had been obtained by Dr. Herman Grunow of Iowa County, Wisconsin and noticing the superiority of the variety by a home test, he brought the matter to the attention of Professor Daniells. From these initial seeds a quantity of grain was grown on the University Farm, and widely disseminated over the country, with immense profit to the growers and users of the product.

In 1869, there being no branch of the United States Signal Service nearer than Milwaukee, the systematic obervation of weather conditions was undertaken by the agricultural experiment station officials, and local meterological records were continuously made from that time. The professor of agriculture also acted as public analytical chemist. Professor Daniells, ably assisted by Dr. John E. Davies, was accounted one of a group of scholars who placed the teaching of science in the University upon a solid basis.

Farmers had evinced little general interest in the work done in behalf of agriculture before the advent of President John Bascom L.L.D. who came from Williams College in 1874. Under his administration, the University quickly progressed. Funds for its conduct were, however, inadequate, but in 1876 the legislature provided a higher income by special levies. In 1877 Science Hall was opened and in 1878 Washburn Observatory was completed and the following year, was enlarged.

The Coming of Professor Henry

In 1880 William Arnon Henry was appointed professor of botany and agriculture, relieving Dr. Birge of the former branch and Professor Daniells of the care of the University farm.

Prof. Henry was born at Norwalk, Huron County, Ohio, June 16, 1850. He graduated from Cornell University, New York in 1880 with the degree of Bachelor in Agriculture. In that year he served there as assistant instructor in botany. Previously he had been principal of the high school at Boulder, Colorado. When he joined the faculty of the University of Wisconsin in 1880, he first taught botany, then agricultural subjects with, later, special attention to feeds and feeding.

The legislature of 1881 made the first appropriation by the State to the agricultural department of the University. The law enacted (Chapter 211) provided $4,000 for experiments in cultivating amber and other varieties of sugar canes, the manufacture of syrup and sugar therefrom, and the ensilage of fodders. Farmers had urged research work in this subject. The experiments then begun were continued through 1882, A further appropriation of that year (Chapter 233) providing $2,000. Of the experiments, President Bascom wrote "they were vigorously and successfully prosecuted by the agricultural department of the University."

Magnus Swinson, an emigrant from Norway and a graduate of the University of Wisconsin, who became wealthy and nationally famous later in life, was the chemist employed in the sugar work. A small sugar plant was built near the lake shore, northwest of the Washburn Observatory, and a considerable quantity of excellent sugar was made from amber cane. About the same time a silo was built and filled and feeding experiments with corn silage were conducted. These experiments continued through two years.

Amber Cane and Ensilage Experiments

In 1882, Professor Henry published a special report entitled "Experiments in Amber Cane and the Ensilage of Fodders at the Experimental Farm" as the result of work done in 1881. Five thousand copies were printed in compliance with a joint resolution of the legislature, and in conformity to Chapter 211 of the general laws of 1881. It showed that good marketable sugar can be obtained from amber cane, at the rate of 1,000 pounds to the acre, by methods even more practicable when used on a large scale than was possible at the Experiment Station. A twelve-page circular relative to amber cane had also been published that year, and 3,000 copies distributed.

The report gave information about the machinery used; the general properties of cane sugar: the varieties of cane tested; effects of leaving cane cut in the field, under shelter and stripped in the field; defecation; use of sulphurous acid; boiling of syrup; the diffusion process; methods of making syrup; consumption and production; cost of production; the sucrate of lime process; production of sulphurous acid;

cane seed for feed; value of fertilizers, and a list of syrup manufacturers in Wisconsin.

A second annual report was published in 1883, dealing with the results of work with amber cane in 1882. The chief purpose of the continued research work was to ascertain the cost of manufacturing sugar in quantity in a commercial way. The report showed that good raw sugar had been made on the Experimental Farm at a cost of only four and one-half cents per pound.

Twenty-six varieties of cane were grown on the farm, to determine which were the best for sugar and syrup. Experiments were also made with various fertilizers, to ascertain their influence upon the cane juice. The report also gave advice regarding the best methods of cultivating and managing the cane crop, as the result of two years of experimentation. Early Amber was the only variety, of those tested, and used for sugar making, as it was about the only one to mature. Even this variety did not reach full maturity, many of the heads being hardly beyond the milk stage.

The experiments with fertilizers disclosed the fact that the cane is entirely independent of the soil for material from which to form sugar, and although fertilizers may prove beneficial on some soils, they proved useless when used on that of the Experiment station.

Early Silage Experiments

Professor Henry's 1882 report of experimental described work done in 1881 relative to the ensilage of fodders. A silo had been built during the summer of 1881, and was really, a stone cellar with cemented walls, or might be termed an immense cistern.

It was 30 feet long, 15 feet wide, outside measurement, and 15 feet deep, with walls 18 inches thick, made of sandstone rubble laid in strong mortar. It had no doors or opennings of any kind on the sides or bottom, which were well coated with cement to made them air and water tight. Over the silo was a low frame building with the sides 6 feet in height and 11 feet to the peak of the roof. Inside of the structure was a 3 foot wall of 2 inch plank, set on edge, running all around it forming a continuation of the stone wall of the silo proper. By means of this plank wall the silo could be filled with ensilage three feet higher than the stone wall; but settlement of the silage was expected to level it in the silo. The silo was entered from the main barn floor, which was on a level with the top of the stone wall, a doorway being cut in the side of the barn for that purpose. A ladder was used to reach the bottom of the silo. The ensilage was passed out through large double doors, at the end of the super structure. The total cost of the silo was $413.42.

Fodder corn was used to fill the silo. The varieties used were two plots of a yellow dent corn which had been grown upon the experiment farm for several years, and one 3-acre plot of White Australian flint corn, which had also been grown on the farm for some years. The yellow dent yielded about 12 tons and the flint corn about 16½ tons to the acre. The fodder was fresh and green when cut and placed in the silo. The weather was warm and the silage heated rapidly. Five tons of second growth green clover were mowed and placed in the silo without cutting, but well spread and tramped. The clover was then covered with two-inch plank 10 inches wide, extending across the silo from wall to wall, but cut about an inch shorter than the width of the silo, to prevent binding thru settling. Stones, weighing 112 pounds to the square foot, were next placed on top of the planks. During the heating process the cut corn fodder which, when fresh, filled the silo fourteen feet, sunk to ten feet. The cost of filling the silo was $132.75, about 6 days being spent in the work. The cost per ton, for filling was placed at over one dollar and sixty cent, "which," wrote Prof. Henry "is fully twice what it should have been, owing to some aggravating blunders," the ensilage cutter failing to work perfectly, two horses in a trend power being insufficient to work the cutter and a threshing machine sweep power, worked by four horses having to be procured.

When opened, the clover was so moldy and inferior that it had to be discarded, but the corn fodder was in fine order from the top, but drier than expected, though more moist lower down. "Cows that refused the silage entirely at first, soon fell to tasting it and after four or five feeds, they all ate it as naturally as hay." Even the discarded clover hay was in time, eaten with relish.

A miniature silo was also made by digging a hole 8 feet by 8 feet, in the ground well drained by proximity to a rail-road cut. The soil was compact and gravelly. Into this "pit silo" green clover, directly from the field, was thrown, and tramped down as closely as possible, more and more clover being put in until it formed a mound rising above the ground. Upon this, straw was placed; then some planks, and them some earth taken from the pit was thrown ~~in~~ on top to form a high mound. More earth was put on, as the first layer settled level with the ground. Wet weather followed, but no additional cover was put on. When opened, in due course, the clover came out in perfect condition, very moist and natural in color. Cows ate it greedily.

The 1883 report of work done in 1882 gives the results of experiments made to determine the relative value of dried fodder corn and ensilage for milk cows.

A new silo was made for the work by excavating the face of an embankment, about seven feet in height, to the depth of fifteen feet, and a width of twelve feet, with the bottom on a level with the ground at the foot of the embankment. Scantlings two by four and ten feet long were placed edgewise upright, as studding, about the sides of the excavation, and also at the open front. Boards were then nailed upon the inside of the scantlings, and carried to the top of the studding, to make a room twelve by fifteen feet and ten feet high. Where the scantlings extended above the seven foot deep pit, and at the open front of the room or box, boards were also nailed upon the outside of the studding. The four-inch space thus formed was filled with earth to exclude the air. The box was then divided into two tow compartments by scatlings set upright through its middle, boarded on the both sides and the space then filled with earth. Two small silos, each about fourteen feet long, and nearly six feet wide, and ten feet deep, were thus formed. The floor was of earth, and the roof of old boards, well lapped to keep out rain. The fodder corn used in the experiment was placed in one of the compartment of this sil

On September 4th and 5th the silo was filled by using nine of eighteen rows of dent fodder corn, and four rows of eight rows of Dr. Bailey's ensilage corn. This corn was cut into three-fourths inch lengths, and the silo filled to the top, with inch boards over it and three two-horse loads of stone over them to give weight. The ensilage had settled nearly one-half, by feeding time

On September 6th the other nine rows of dent, and four rows of Dr. Bailey's fodder corn, were cut and shocked, the corn being in full blossom at the time. On October the shocks were bound into bundles and placed under cover. By this plan was secured an equal amount of green fodder to start with, one-half made into silage and the other half dried in the customary manner.

Four cows, whose qualities as milker's were well known, were used in the comparative feeding experiment. Two of these were fed all the corn fodder they cared to eat, in addition to 1 pound of bran, 1 pound of corn meal, and 1½ pounds of oil meal, per cow at a feed, twice a day. The other two cows were fed all the corn silage they could clean up, between the two feeds of meals which were the same for both lots. The results may, briefly, be summarized as follows. The silage lasted the two cows 70 days. The shocked corn fodder lasted the other two cows 47 days, or nearly 50 per cent in favor of the silage. The two fodder fed cows yielded, in the first trial of 21 days, 689 lbs. 1 oz. of milk and 31 lbs. 7 ozs. of butter, and the two silage-fed cows 791 lbs. 13 ozs. of milk and 28 lbs. 0 ozs. of butter. In the second trial of 21 days, thetwo fodder-fed cows yielded 633 lbs. 14 ozs. of milk and 21 lbs. 14 ozs. of butter, and the two silage fed cows 664 lbs. of milk and 31 lbs. 8 ozs. of butterfat; or totals of 1,322 lbs. 15 ozs. of milk and 53 lbs. 5 ozs. of butter for the 2 fodder-fed cows, and 1,456 lbs. 8 ozd. of milk and 59 lbs. 8 ozs. of butter for the 2 silage fed cows. The cows fed fodder gained 10 lbs. in the first trial and 16 lbs,.in the second as against 24 lbs. in the first trial, for the silage fed cows, and a loss of 39 lbs. in the second trial. The fodder-corn was coarse and much of it was left as refuse stalks.

A test of the effect of feeding silage to calves showed that 1 pound of medium quality blue grass hay equalled 3.6 pounds of ensilage. Each calf was also fed 2 pounds of oil meal, 2 pounds of bran and 4 of oats per day, divided into 2 feeds. Some of the silage offered froze and was discarded. The impression gained from the test of the scales was very favorable to ensilage all the way through the experiment.

Corn silage fed to 2 two-year old steers, and to 2 one-year old heifers as the sole feed for 2 weeks, induced an average gain of 3.42 pounds a day for the 2 steers, and 1.92 pounds a day for the heifers.

From his preliminary experiment with ensilage, Professor Henry concluded that, "While ensilage goes with high farming, which is not the common method at the west," many farmers could use the silo to advantage and profit," but he advised them not to build expensive silos until they had tested ensilage in a small way, by means of an inexpensive silo or simply fodder buried in the ground. Thus, he believed, the experience gained would pay when it came to erecting larger silos.

Construction of Silos

Based upon his experience with the first trial silos constucted on the Experiment Station farm, Professor Henry advised, in his report on ensilage work in 1882, that silos may be made of any material that will answer for walls and exclude air. The silo, of stone or wood, smooth lined, and set where water will not seep in, should have but one door and not less than 10 feet deep, and the deeper the better. If possible, not one, but several silos should be constructed. "A large silo should be partitioned off into smaller ones. The reason for this is that small silos can be more rapidly filled and sealed and less ensilage is exposed when the cover is removed. With several small silos at hand one can put in any crop that is ready any time during the summer season. By this means much green feed, that would, otherwise, go to waste can be saved. Again, a small silo can be fed out during a summer drought when pasture is short thus preventing a shrink of the milk. Those who feed silage all come to look upon several silos as essential to the highest success."

Establishing the Experiment Station

When Professor Henry was given charge of the Agricultural Experiment Station, October 1, 1883, he had as associates William Trelease D. Sc. professor of botany; Henry Prentice Armsby Ph.D. professor of agricultural chemistry, and Leslie Adams superintendent of the Station farm.

The appointment of these experts had been made possible by increased revenue voted by the legislature of 1883.

Prof. Trelease had been professor of botany from 1881 and served until 1885; then he was director of the Botanic Gardens, St. Louis, Mo., and professor of botany in Washington University. Professor Armsby served from 1883 to 1887 and was specially interested in animal nutrition. In 1887 he was appointed Director of the Pennsylvania Agricultural Experiment Station and continued in that position, until 1907, when he was made Director of the Institute of Animal Nutrition and became nationally renowned as an expert in that subject.

Hid books on cattle feeding, principles of nutrition, nutrition of farm animals and the conservation of food energy, did much to advance a scientific knowledge of the feeders art.

Dr. Arms~~ley~~by no doubt imbued Professor Henry with much of the enthusiasm relative to animal nutrition which led him to specialize in that subject. Dr. Arms~~ley~~by was honored with the degree of Doctor of Laws by the University of Wisconsin, in 1904, and continued to do admirable work, at Pennsylvania State College, until the time of his death, October 19, 1921.

In August 1883 the first bulletin of Wisconsin Experiment Station was published and the first annual report followed in 1884.

Professor Henry, like his predecessors, met at first, with difficulties and opposition in his work. One of them was the vandalism ~~of~~ by some of the students. He reported, not long after coming to the University, that it would be futile to continue experiments in horticulture as long as the spirit of mischief prevailed. Gradually, however, conditions improved and, at length, the agricultural department and its officers were given the respect and deference they deserved.

At first Professor Henry and his wife occupied three rooms in the University Farm house, which had housed the "Agricultural Department" since 1880. The foundation"equipment of the department was a small walnut desk table, bought for $2.50, and placed in the front room of the second story of the house. This table is, treasured in the Agricultural Library today, as the oldest piece of furniture owned by the Agricultural Experiment Station and College. The rest of the office equipment consisted of an inkstand, a little stationery and some record boods. Later four rooms, used as students' living quarters, on the third floor of the south half of South Hall erected in 1855, were vacated and utilized for the offices, library and chemical laboratory of the agricultural department. In time, the entire building was turned over to that department.

The First Experiment Station Bulletin

The first bulletin of the agricultural Experiment Station, which succeeded, the experiment farm, October 1, 1883, was issued in August 1883, and the first annual report for the three months from October 1, 1883 to December 31, 1883, was published in 1884. During this short period no extended experiments could be complete therefore the report presented, largely, results of experiments made previous to the establishment of the station, but not hithert published.

Feeding Milk and Cornmeal

Bulletin No. 1 offered, first, an analysis of 1,000 pounds of average milk, and then outlined the results from feeding skimmed milk and soaked and slightly soured corn meal separately to two lots of Poland China pigs. The average of the two trials showed that 400 pounds of corn meal, or 1,900 pounds of skimmed milk were required to produce ~~again~~ a gain of 100 pounds of live weight.

The next test, with four lots of pigs, feeding milk and corn meal together, showed that Lot I fed 14 lbs. of milk and 3½ lbs of meal for 100 lbs. of live weight required 130 lbs. of meal and 880 lbs. of milk for 100 lbs of growth. Pigs in Lot II given 326 lbs. of milk and 2½ lbs of meal per 100 lbs. live weight, required 960 lbs. of milk and 96 lbs. of meal to produce 100 lbs. of pork. Lot III fed an excess of 33 per cent of carbohydrates by allowing 9 lbs. of milk and 5½ lbs of meal per 100 lbs. of live weight, required 200lbs. of meal and 330 lbs. of milk for 100 lbs. of growth. Lot IV received all the corn meal soaked until slightly sour, they could eat and required 500 lbs. of meal for 100 lbs. of growth which allowed at that time (1883) one dollar per 100 lbs. for the meal.

In the next trial reported four very lean ~~shotes~~ shoats " of uncertain age and breeding," were placed in pens, in pairs, and fed milk and meal together. Lot I received after the first day of preliminary feeding, 12 lbs. of meal and 42 lbs of milk, in 3 feeds, per day, for 25 days. They required 230 lbs. of meal and 800 lbs. of milk, for 100 lbs. of gain giving the milk a value of 34 cents per 100 lbs.. Lot II, given, after the first day, 6 lbs. of meal and 60 lbs. of milk, in 3 feeds, daily, required 148 lbs. of meal and 1,485 lbs. of milk for 100 lbs. of gain making the milk fed worth 24 cents per 100 lbs. It was noted that the German Feeding Tables "were no guide to economy, and that a feed ration where there was an excess of carbohydrates, according to the tables, was superior to one where protein was in excess." The test with Lot IV, however, indicated that, if the amount were allowed to sink too low, very unsatisfactory results would follow.

Skim-milk as Calf Feed

During the summer of 1883, three grade Holstein calves were fed skim-milk, along with "old process" oil-meal and a little whole oats. The meal was scalded with water to make a "pudding" with which the milk was mixed, at a temperature of 90 degrees, before feeding. The oats were fed from a box. A heifer calf, dropped Jan. 22, 1883, was fed 18 lbs. of milk with a little meal, twice a day, from June 5 to July 26. It soon refused to eat oats. During the trial of 51 days, in which it had access to a small pasture, it ate 18½ lbs. of oats, 108 lbs. of oil meal, with 1,632 lbs. of milk, and gained 113 lbs., or 2½ lbs. per day. Another heifer calf, dropped April 1, 1883, and a bull calf dropped April 22, were fed in the stable for 51 days. The heifer was unthrifty from birth and made unsatisfactory growth. She consumed 1,208 lbs. of milk, and the bull calf 1,437 lbs., while the two together ate 113¼ lbs. of oil meal and 78 lbs. of oats. The heifer gained 82 lbs; and the bull 120 lbs. in 51 days. A gain of one and three-fifths, and two and one-third pounds respectively per day. The calf fed by itself gained 1 pound for each 14 pounds of milk and 1 pound of oil meal fed. The two calves fed together gained one pound in weight for 13 pounds of milk, ½ pound of oil meal and 1/3rd pound of oats. The calf born January 22nd, weighed on August 13th, 514 lbs. which Prof. Henry considered certainly a sufficiently rapid growth, where a good milking cow is the object. He advised dairymen to obtain such development in their heifer calves, and to select and rear calves from their best milking cows. He concluded Bulletin No. 1 with the remark: "Thousands of calves are slaughtered in our state every year, that have in them the elements of as good milkers as most of the cows imported from other countries at large prices."

The First Annual Report

The first annual report for 1883, published in 1884, explained the purpose of the Experiment Station, described its equipment for research work, and offered to analyze fertilizers, fodders, milk, soils, etc.; to test farm and garden seeds as to purity and vitality; to identify grasses, weeds, fungi (rusts, smuts, mildews, etc.) and noxious and beneficial insects;

and, in general, to do all work proper to an experiment station, for the use and advantage of the citizens of Wisconsin.

A report followed regarding a test of 11 varieties of wheat received from the Ohio State University, through the courtesy of Prof. W. R. Lazenby and sown in the fall of 1881. Of these, the Velvet Chaff variety proved worthy of trial, yet none of them could be recommended with confidence. A sample of French Imperial spring wheat was also tested and proved unsatisfactory. Prof. Henry commented that spring wheat has never given satisfactory results on the experimental farm, and added "Today Wisconsin is most prosperous where the least spring wheat is grown, and the least prosperous where the most is grown."

Three varieties of oats were grown, without one proving better than the others. Salt, used as a fertilizer for oats in another test, had beneficial effects, seen in brighter, stiffer straw, and plumper grain. It was mentioned that the beneficial effects of salt have been so marked, in several localities of Wisconsin, that from half a barrel to a barrel of salt per acre is sown each spring upon the small grains. In a few instances, however, no benefit having accrued, salting of land has been abandoned. Prof. Henry concluded the section of the report regarding the application of salt with the following wise counsel: "Salt and barnyard manure are to the growing crops, as a whip and oats for a horse. You may get work from the horse for a time, by use of the whip; but sooner or later oats must be given or the work will cease."

The report also contains an account of the introduction and dissemination of Mansury barley; a negative experiment relative to corn smut; articles by Prof. Trelease about onion mold, apple scab and leaf blight; particulars about the skim milk and meal feeding experiments, already summarized; a summary of meterological observations made, at Madison, during the period 1853-1883, and an account of miscellaneous chemical and other work done by Prof. Armsby.

In 1883, the importance of ensilage becoming apparent, Prof. Henry secured the services of John Gould, of Ohio, to do institute work on the subject and through the influence of that expert, interest in the new feed for dairy cows was wide spread.

Progress Made in 1884

Prof. Henry's second annual report, for the year 1884, submitted to Governor J. M. Rusk, by Hiram Smith, chairman of the farm committee of the board of regents, August 6, 1885, showed material progress in the work of the experiment station. Professors Henry, Trelease and Armsby were still the officers, and Leslie H. Adams the farm foreman. The Station staff had also been strengthened by the addition of Frederick Garland Short, as assistant chemist and William H. Moore as dairyman.

During the summer, the main barn was extended 36 feet in length to afford room for feeding trials, storage of experimental fodder etc., and facilitate care of the Station livestock when not in use for experimental purposes. The basement of the barn was also equipped as a cow stable, and running water provided. A twenty foot, geared windmill, donated by the Eclipse Wind Engine Co. of Beloit, Wis. was installed. Old South Hall or Dormitory was remodelled to accomadate the Station offices, and renamed Agricultural Hall.

The cost of the remodelling and equipment of the building, to the full extent desired by the officers of the Station, was borne by the University. No part of it having been charged to the Experiment Station, and the latter occupied the rooms free of all charge for rent, fuel, gas or janitorship. The Station dairy herd had also been improved, by sales and purchases, so that suitable animals might at all times, be available for experiments on milk and butter production.

During 1884 were published Bulletins No. 2. "Amount and Conditon of Seed Corn in Wisconsin;" No. 3. "Composition and Digestibility of Fodders;" and No. 4. "Experiments on Milk Production."

Corn Varieties Tested

The study of the amount and condition of seed in the state disclosed an abundance in some sections and a dearth in others, while much of the seed, especially in the northern counties, had low germination power or was practically worthless. Experiences the previous season had proved Nebraska and Kansas grown seed corn unfit for Wisconsin conditions, and it was predicted that seed from Ohio and Pennsylvania would prove equally unsatisfactory. The Leaming variety of dent corn claimed to ripen in 90 days, was found wholly unfit for Wisconsin by the tests made at the Station. It did not ripen in less than 110 to 120 days. Repeated testing of seed corn for germinating quality was advised, and it was believed that seed corn from Minnesota or Northern Michigan would be most suitable, while some of that from New York and Vermont might prove of fair quality. It was urged that farmers should try to secure an enlarged acreage of corn in 1884, by planting good seed, securing a good stand and giving the crop thorough tillage.

The Quality of Fodders

The experiments described in Bulletin No. 3. were undertaken to learn the chemical composition and the amounts of digestible matters contained in various fodders including those in common use in Wisconsin. A table was published showing the results of the analysis made to determine the composition of clover hay, malt sprouts and cotton seed meal and an explanation made of the terms used and feeding values of the elements mentioned. The method of analysis practiced was that worked out at the German experiment stations. Sheep were used for the feeding experiments. The average digestibility of clover hay proved somewhat less than that found by the German investigators, particularly as regards protein and fat, while the crude fiber was somewhat more digestible in the Wisconsin hay.

Soaked malt sprouts, fed warm in conjunction with hay, showed the following percentages of digestibility. Dry matter 67.4; organic matter 67.5; protein 80.3; crude fiber 33.8; nitrogen free extract 68.6; fat 100. The sheep fed, received 600 grams of clover hay and 175 grams of malt sprouts daily. No previous determinations of the digestibility of malt sprouts had, so far as known, been made.

Each sheep fed in the test to determine the digestibility of cotton seed meal received per day 700 grams of hay and 175 grams of cotton seed meal. The percentages digested were:

Dry matter 80.8; Organic matter 80.03; protein 88.2; crude fiber 0; nitrogen free extract 67.3, and fat 100.

Milk Production Tests

There being a general belief that, other things being equal, those rations are most favorable to the production of milk which contain a liberal proportion of digestible protein, the experiments described in Bulletin No. 4 were undertaken. In a first period, cows were fed clover hay and corn meal in amounts which made the ration contain 1 part of digestible protein to about 8 parts of other digestible matter. The amount of hay fed was the same throughout the experiments. In a second period, part of the corn meal was replaced by an amount of cotton seed meal containing the same amount of total digestible matter. The altered ration then contained about 1 part of digestible protein, to 5½ parts of the other digestible matters. In a third period, malt sprouts replaced cotton seed meal. The total disgestible matters and the proportion of protein remaining the same. In a fourth period, the same ration was given as in the first. The hay fed was nearly pure red clover, and of good quality. The corn meal was from Wauskakum (flint) corn, grown on the University farm. The cows were watered, and milked twice a day.

Variations in milk produced during the tests emphasized the importance of a proper selection of dairy cows. A Jersey, native and grade Jersey, were used in the experiment and responded so differently to the feeds furnished that Prof. Henry concluded; "A comparison of the three cows with each other shows very pointedly how entirely a secondary matter is the feed as compared with a proper choice of animals. The native cow produced the most milk "because her organization was such that she could work over a larger proportion of her feed into milk"; but she showed a greater shrink in milk during the tests, than did the two other better bred cows. Period II showed a gain and period III, in general, a loss, as compared with the clover hay and corn rations of periods I and IV; but the differences were small. "Increasing the proportions of protein in the ration, by substituting cotton seed meal or malt sprouts for corn meal, had no effect upon the production of milk" and the yield of milk corresponded to the variations in the total amount of food digested, and not to variations in the proportion of protein.

There was no indication that the food influenced essentially the composition of the fresh milk. The percentage of butter fat in the first period was 3.84, second period, 3.65, and third period, 3.42. The test failed to show any improvement in the churning qualities of the milk resulting from the use of cotton seed meal or malt sprouts; but in conclusion, farmers were advised that, without further evidence, they should not condemn oil-meal or cotton seed meal as feed for milk cows, but would do well to satisfy themselves of their advantage before investing in large amounts.

The Setting of Milk

The second annual report also gave the results of experiments in setting milk. Deep setting was found to commend itself by being inexpensive, saving labor, giving uniform results, and leaving the skim milk in its most valuable condition. To avoid loss the cans of milk should go into the water tank at once. Delay may cause a loss of from four to more than nine percent of the butter made. No advantage resulted from heating the milk before cooling.

In the second annual report Prof. Henry also gave information regarding the Sehoob and Bolinder test churn; the value of the dropping of corn fed steers for hogs; the feeding of bunty wheat screenings; grasses for hay and permanent pasture; comparative values of several new varieties of sorghum; a bull pasture fence; and new machinery tried. Prof. Trelease reported on spot disease of strawberry leaves, and Prof. Armsby on analysis of milk and of fertilizers. Meterorogical observations were furnished by the Washburn observatory.

Progress Made in 1885

The work of the Experiment Station progressed without interruption during 1885. The annual report for that year really covered approximately, the period from April 1, 1885, to April 1, 1886. While a number of minor topics received more or less attention during the year, the general subject of cattle feeding was chiefly studied, along the following lines: 1. The feeding value of skim milk for young animals including also studies upon the rearing of young calves. 2. The value of the corn crop as fodder, and the effect upon its value of different methods of curing and feeding. 3. A study of the value of oil meal and similar fodders for milk and butter production. 4. The relative value of corn and shorts for pork production.

Five bulletins were published during the period mentioned, viz; Bulletin No. 5 Analysis of feeding stuffs; No. 6 Experiments in calf feeding, and analysis of fertilizers;

No. 7, Experiments in calf feeding, and the Cooley College system of creaming milk; No. 8 Oil meal vs. corn meal for milk; No. 9. Report on oats, patatoes and corn for 1885, published March 1886.

F. W. A.W. Woll Jomis JOINS The Station Staff

In the third annual report for 1885, and in the later bulletins published in that year, the name of Fritz Wilhelm A. Woll appears for the first time as one of the chemists of the Experiment Station. He was a native of Norway and had received his Bachelor of Science degree from the State University (Christiania) of that country in 1882. In 1886 he obtained the Masters' degree and in 1904 the Doctors degree from the University of Wisconsin. He was second assistant station chemist, 1887-1890; assistant chemist, 1890-7, and chemist 1897-1913. He was an earnest worker, accomplished linquist, and an instructive writer, especially in the line of animal nutrition. He continued work in that branch of science in the University of California, at Davis, until the time of his death there December 5, 1922. Dr. Woll was the author of several useful agricultural text books of which his "Productive Feeding of Farm Animals", published in 1915 was perhaps most notable.

A. B. Seymour, B.S. was also mentioned as an assistant chemist in Bulletins Nos. 7, 8 and 9 but not in later bulletins.

Calf Feeding

Wheat growing having become unprofitable, Northern Wisconsin, and dairying having been begun there farmers were advised, by the Experiment Station officers, to stop the indiscriminate slaughter of calves and to rear the choice ones on sweet skim milk. To throw light upon the problem of calf raising, 6 calves were fed from 6 to 11 quarts of sweet skim milk daily. The milk was from the Cooley Creamer and was warmed to 98°F. before feeding. All the calves, with the exception of the oldest, were fed 3 times daily, and all received oats, bran, oil meal, hay and ensilage all or part of the time. To prevent scouring, 1 tablespoonful of lime water was added to each meal of milk. The calves were fed for 21 weeks.

The average return from the 6 calves for the whole period of 21 weeks after allowing for all other food articles consumed was 48 cents per 100 quarts of skim milk or about 24 cents per 100 pounds. The 6 calves together gained 1544 pounds, being an average of over 12 pounds each week. The calves were fed by William H. Moon. Prof. Henry advised, in his report of the experiment: "Dismiss all prejudice that a skim milk calf must be a stunted, unsightly thing. We are making as great advancement in calf-rearing as in butter or cheese making, and old ideas must be put away."

Fertilizer Analysis

The fertilizers analyzed in 1885, were called by the manufacturer "tobacco fertilizers" but the tests made indicated that they were as well adapted to tobacco as to any other crop, and as well to any other crop as to tobacco. It was Prof. Henry's belief that the idea that fertilizers can be compounded which shall be specially suited to the requirements of particular crops, though a favorite one with manufacturers, is nevertheless an erroneous one, based on an imperfect understanding of soil, crop and fertilizer.

Further Calf Feeding

As only a few calves were fed in the trials reported in Bulletins Nos. I and VI and those calves were from the Station stock, it was decided that a new trial should include ordinary cheese district calves and some of the common stock raised about Madison. It had been suggested that the ones previously used were scarcely fair examples for the average farmers or for those who might wish to buy up calves from the cheese districts, for feeding. Nine calves were, therefore, bought from farmers supplying cheese factories, and seven ordinary calves were purchased in the Madison district. They were, on the whole, a fair lot. Fourteen of them were bulls and these were castrated during the second week of the feeding trial. The calves were tied in separate stalls during the days and allowed exercise in the barn yard at night, until old enough to eat grass, when they were furnished good night pasture.

At first 1 part whole milk was fed to the youngest; but this was soon changed to skim milk. Each was fed 15 lbs. of sweet bloodwarm skimmed milk daily, in 3 feeds. Gradually the allowance of milk was lessened until, toward the end of the trial, little over 10 lbs. per day was given in 2 feeds. The calves did not relish whole oats, so were fed ground grain. When tired of one grain ration, another was substituted, and fed, after giving them the milk. A little hay was allowed at first and, later, green grass in abundance was substituted.

A total gain of 2, 560 lbs. was made in 14 weeks. This made the milk worth 35.1 cents per 100 lbs. or over 35 cents per 100 for skim milk when, owning to the low price of cheese farmers received only from 30 to 60 cents per 100 for full milk at the factories. The calves came out of the test "a thrifty lot of young things," and were paying well for all they ate. Prof. Henry, in commenting on the test said that: "In every cheese district of the state there should be creameries or private parties that could feed all the best calves and thus make it profitable for those producing milk to use good bulls."

The ~~Mc~~Cooley Creaming System

Prof. Armsley by tested the Cooley system of deep setting milk, to determine exactly the efficiency of the process in separating the fat from the milk. Between two and three hundred tests of individual cows had been made, the milk and skim milk being weighed and analyzed, thus furnishing data for judging the efficiency of the system. Three cows were used in the experiment reported in Bulletin No. 7 vz: "Nibbie" a registered Jersey, and "Jersey" and "Sylvia" Jersey grades. The results of the test were exceedingly satisfactory. From 92, to almost 98 per cent, of the fat of the milk was recovered in the cream in 11 hours, and the percentage of fat in the skim milk was reduced to between 0.7 and 0.2 per cent, or as low as is possible by any process except use of the centrifugal. In the experiment reported, the variations of temperature were too small to have any appreciable effect upon the creaming. The temperature of water in the tank was from 33.3 F. to 36.9 F. The most complete creaming was obtained with "Nibbie," and the poorest with "Jersey," while "Sylvania" stood between the two in this respect. Prof. Armsley concluded that "Such differences are probably connected with difference in the size of the fat globules of the milk, and in the breeding of butter cows this is a point will worth attention."

Oil Meal vs Corn Meal for Milk

Experiments in the feeding of concentrates to dairy cows, additional to those reported in Bulletin No. 4 of the Experiment Station were conducted by Prof. ~~Armsbey~~ Armsby from February 1, 1885 to May 2, 1885. Like the original one with cotton seed meal and malt sprouts, the new experiment was made to determine whether highly nitrogenous foods, like the various kinds of oil cake, have a higher nutritive value than starchy foods like corn meal and bran for dairy cows. New process oil meal was used for the test. Three cows were used, two of them Jerseys and the other a Jersey grade. Each cow, throughout the experiment, was fed per day, 5 lbs. of "new process" wheat bran, 4 lbs. of corn meal, 8$\frac{3}{4}$ lbs. of clover ensilage and 17$\frac{1}{2}$ lbs. of mixed hay. The hay feeding was practically ad libitum. This was the fundamental ration. To it were added the articles of feed it was desired to test, as follows: In period I, 3 lbs. of corn meal; in period II, 3 lbs. of new process oil meal; in period III, 3 lbs. of corn meal and 2$\frac{1}{4}$ lbs. oil meal; in period IV, the same as in period I, viz., 3 lbs. of corn meal. The results of the experiments were inconclusive as the animals showed a considerable loss of weight. Neither these, nor the previous experiments in the same line, showed with certainty that oil meal had any greater feeding value than corn meal. The balance in favor of oil meal was slight. Prof. Arms~~ley~~by gave it as his opinion that the "starch equivalent" of feeding stuffs probably "pretty nearly represents their relative value as food." If the apparent gain under oil meal feeding was real, the cost of feed was about 4 cents less per 100 lbs. of milk when oil meal was fed. The oil meal appeared to have improved the quality of the milk by making it less watery. There was no evidence that it altered the proportion of fat to other solid matters.

Oat, Potato and Corn Tests

In Bulletin No. 9 issued in March 1886, tests of several varieties of oats showed that White Shonen, which had been grown on the Station farm for years, led the others in yield, though the grain is not very heavy.

Tests of 15 varieties of potatoes showed Alexander's Prolific first in yield at the rate of 327 bushels per acre; White Star second with 321 bushels; Early Sunrise, third with 316 bushels; Pearl of Savoy fourth with 309 bushels and Crane's Potentate fifth with 302 bushels. In cooking qualities ~~quantities~~ Alexander's Prolific, Early Harvest and Early Sunrise were extra fine. Rot injured the crop. It was general throughout the state. An article on rot was therefore included in the bulletin from a report of Michigan University.

Fifteen varieties of corn were grown on experiment plots. Mandan Indian, or Squaw Corn, matured August 15th with a fair yield and was pronounced worthy of a trial in northern Wisconsin. French yellow, (from France) matured August 25, but was not considered worthy of further trial. Waushakum, a yellow flint, ripened September 10 and was esteemed a valuable variety. North Star Golden Dent, a fine yellow dent corn, was recommended as an excellent corn for Wisconsin.

In the third annual report Prof. Henry also described two trials on Cut Versus Uncut Cornstalks for dairy cows. The tests showed that the uncut fodder lasted 22 days, against 25 days for the cut fodder. The cows on cut stalks made 3 lbs 15 oz., the most butter, but took 3 days longer for the result. The lot in uncut fodder averaged 1.88 lbs. of butter per day, while the lot on cut fodder averaged 1.81 lbs. daily. Cutting the stalks saved 143 lbs. of coarser parts of the fodder, but was eaten slower. The advantage from feeding cut fodder was deemed "not enough to pay for the labor under any circumstances."

Clover Silage for Cows

A trial of clover ensilage, as a partial food for dairy cows, began May 21, 1885 and closed June 9, 1885, when all of the food ensilage had been consumed. In addition, clover hay and a grain ration of 6 lbs. of corn and barley meal per cow per day and an equal amount of bran was fed. From the feed consumed, 3 cows in 19 days, returned 1,342 lbs. 2 oz. of milk, which made 63 lbs. 2 oz. of butter. The food necessary to produce 1 lb. of milk cost 77 cents a 100 lbs., and that necessary to produce 1 lb. of butter 10.3. The skim milk and butter milk, left after making the butter, would at 25 cents per 100 lbs., be worth $3.19. Deducting this from the cost of the feed showed that the butter cost 11.2 cents a pound for the feed consumed. The cows consumed more feed than the German Tables showed necessary to maintain the full flow of milk. Were the German tables correct as a guide, half as much clover hay could have been fed with as good results. Prof. Henry remarked "Whether or not that is a fact unfortunately we cannot tell."

Soiling Versus Pasturing

Six cows were used, three in each lot, to test the practicability of cutting and carrying feed to dairy cows, instead of letting them graze. The results showed that, for one season at least, just as good results can be had from half the land by soiling, as when pasturing.

Feeding Experiments with Pigs.

In experiments in pig feeding, recorded in the third annual report 9 plain bred pigs, with some Berkshire blood in them, were divided into 3 lots, placed in separate pens and for 42 days fed meals mixed with water and allowed to become a trifle sour. Lot I. was fed corn meal exclusively, Lot II roller process shorts; Lot III, a mixture of equal parts, by weight, of shorts and corn meal.

The test lasting 28 days showed that 5.3 lbs. of corn meal, worth 4.3 cents, were eaten by the first lot of 3 pigs: 5.3 lbs. of shorts, worth 3.7 cents, by the second lot; and 3.3 lbs. of shorts and corn meal by the third lot, to make 1 lb of growth. The shorts made the cheaper pork.

In another test, with the same pigs, Lot I, 3 pigs, weighing 550 lbs, in 28 days, ate 449 lbs. of ear corn worth 35 cents a bushel and 224½ lbs. of shorts, worth 70 cents per 100 lbs. and gained 102 lbs., making the cost of pork 4.1 cents per pound live weight. Lot II. 3 hogs, weighing 587 lbs. in 28 days ate 497 1/3 lbs. of ear corn, worth 35 cents a bushel and 248 2/3 lbs. of shorts worth 70 cents a 100 lbs.

and gained 105 lbs. making the cost of pork, live weight nearly 4.4 cents per pound. Two lots of hogs in the last test were then fed ear corn alone for 28 days, with warm water to drink and produced pork at a cost of 4.8 and 4.6 cents per pound.

Four lots of 3 pigs each were fed. Lot I, 1 part of shorts and 2 parts of shelled corn, thoroughly cooked by steaming; Lot II 2 parts shorts and 1 part shelled corn, thoroughly cooked; Lot III the same mixture as Lot I but uncooked and Lot IV the same as Lot II, but uncooked. The hogs fed ~~un~~cooked feed produced pork at a cost of 3.7 cents and 3.4 cents, compared with 3.0 cents and 3.1 cents for those fed uncooked feed. The tests showed a loss by cooking the food of fully one-half a cent for each pound of pork produced, besides the labor of preparing the feed. Prof. Henry also reported tests relative to variation in weight of cows. The uniformity of the water content of butter, the Kellogg system of cream-raising, the results of churning trials with three different churns, grasses and forage plants, and tests of machinery.

Prof. Armsley Armsby contributed illuminating articles on feeding standards and composition of feeding stuffs, and analysis of feeding stuffs, and Prof. Trelease one on the structure of the wheat grain, and of wheat bran. Prof. Arms~~ley~~by also gave information relative to the relation of the fat of milk to the butter yield and an elaborated report of Analyses of Fertilizers. A. B. Seymour quoted the weed law, Chapter 233, published April 7, 1885; and followed with an instructive illustrated paper on Wisconsin weeds, in which he mentioned the following as most needing to be exterminated: Canada thistle, common thistle, burdock, ox-eye daisy, cocklebur, Beggars Lice and couch grass.

The third annual report also contained a report of meterological observations for 1885 furnished by Washburn Observatory, and two tables giving summaries by years and months for the period 1853-1885.

The Experiment Station in 1886

A severe drought experienced in 1886, and extended into the spring and early summer of 1887, somewhat affected the experimental work at the Station, necessitating in some cases a repetition of considerable patient labor expended on some experiments. The seeming loss from this cause was stated by Hon. Hiram Smith, chairman of the farm committee of the Board of Regents, as "more apparent than real" for "among other lessons it taught that the proper time to apply fertilizers is in the fall, winter or very early in spring, so that melting snows can make the elements of the manure available as plant food, some of which (as land plaster) require many times their own weight of water to make them soluble."

Farmers' Institutes were inaugurated, having been placed in charge of the Beard of Regents by an act of the legislature of 1885. Fifty-five institutes were held in 1886, under the efficient management of Superintendent W. H. Morrison.

The fourth annual report of the Station covered the period from April 1886 to April 1887. The limited resources of the Station had been felt more and more, especially as the fund of $15,000 for an experiment station in each state, provided by the Hatch Act, was not yet forthcoming. The report contained a few illustrations. The legislature of 1887 having provided $500 a year for the purpose. During the year, a newspaper bulletin regarding the test of dairy cows at the State Fair was issued September 1, 1886; also a bulletin No. 10 of 16 pages on "Tests of Dairy Cows" at the State Fair. September 1886, and a bulletin No. 11 of 18 pages issued April 1887, gave a report on "Wheat, Oats, Barley, Potatoes and Corn for 1886."

Crop Growing Experiments

The drought, which began in May and did not end until the middle of August, seriously reduced the yields per acre of the various crops grown at the Station. Early corn gave a fair yield, especially where tillage was well kept up. Early potatoes did better than the late ones as the latter having set few or no tubers before the rains came, started to grow again, and were caught by the frosts of September with the tubers in a very immature condition.

As reported by Prof. Henry four varieties of winter wheat, received from the U.S. Department of Agriculture, and labeled Genoese, Indian, White Crimean and Egyptian, were sown September 22, 1885, on carefully prepared and thoroughly under-drained land, winter killed completely. Of 34 varieties winter wheat tested, and sown on the date already mentioned Champion Amber did best, yielding at the rate of 49 bushels to the acre. Therss and York White Chief came next, each with 44 bushels per acre, while Hungarian White Chaff made 42 bushels, Zimmerman, 41 bushels and Arnold's Gold Medal and Bennet, 40 bushels-each. Of 25 varieties of oats, sown April 21, on plats one-twentieth of an acre each, with seed at the rate of 2½ bushels per acre. The variety called Race Horse yielded at the rate of 62.5 bushels per acre, Egyptian 61.8 bushels, Swedish 61.5 bu., White Swede 60.9 bu. and Bonanza 60.3 bu.

The Harris variety had only 25.80 per cent of hull, while the Lost Nation had 35.80 per cent. Some grains of the Bohemian or Hulless variety were found to bear hulls.

Seven varieties of barley were sown April 22 at the rate of 2 bushels per acre. The drought materially injured the crop. Melon yielded 42.5 bushels per acre, Vermont Champion 33.3 bu., Mansbury 33.1 bu., and Sibley's Imperial 31 bu.. Nepaul produced but 19.1 bu. per acre. The seed of the Melon variety was furnished by the U.S. Department of Agriculture

Some 33 varieties of corn were grown in 1886, but the drought detrimentally affected all of them. Pride of the North, proved most suitable for Wisconsin, as an early maturing dent variety. Its kernels were dented September 1. Prof. Henry considered it seemingly a smaller form of Leaming which, very properly, is a favorite farther South. The "Angel of Midnight" variety "was forever condemned when that name was given it by some witless party." The flint varieties, Waushakum and King Phillip were pronounced standard. It was advised that Winnebago White, which matured August 15 should be grown in northern Wisconsin.

Of 45 varieties of potatoes, grown in 1886, when conditions were unsuitable Thorburn led the new varieties in shape, size and flavor, with Early Ohio, best, as an early variety. The General McClellan, Early Pearl and Empire State varieties gave excellent satisfaction on cooking. Dates of maturity for the varieties tested, could not be stated owing to the character of the season.

Feeding Experiments

Tests indicated that there is an advantage in feeding calves curded skimmilk. The curd was made by heating the milk to 90° F. and adding 12 drops of liquid extract of rennet to 14 lbs. of milk. The curd and whey not easily removed weighed about 60 per cent of the weight of the original skimmilk. The calves were allowed bran, oats and hay, in addition to milk curd. The average of 2 trials showed that it required twelve and one-tenth pounds of sweet skimmilk and the curd from 13 lbs. of sweet skim milk for 1 lb. of growth. Hogs were fed sweet skim milk, corn meal and shorts, and others butter-milk cornmeal and shorts. Those fed on the sweet skim milk mixture gained 38½ lbs. more than those fed on buttermilk ration. Valuing the shorts and corn meal at $15 per ton, and hogs at $4 per 100 lbs. live weight, the sweet skim milk was worth 20.6 cents per 100 lbs., and the buttermilk 14.7 cents per 100 lbs. With hogs selling at $5 per 100 lbs., and cornmeal and shorts at the same price as before, the sweet skim milk would have a value of 35 cents per 100lbs., and the buttermilk 28 cents per 100 lbs.

The Oil Test for Cream

In Bulletin No. 12., issued October 1887, Prof ~~Armsley~~ bey and F. G. Short reported the results of a trial of an "oil test churn," manufactured by Cornish, Curtis and Greene, of Ft. Atkinson, Wis. The purpose of the churn was to determine only the churnable fat of the milk or cream, or its equivalent in butter, and not the total fat. They found that the churning, as a rule, is not as complete in the oil-test churn as in the large churn. In the oil-test churn trials the percentage of churnable fat, varied considerably in duplicate samples, and did not as a rule agree closely with the percentage obtained by the large churn. Out of 16 trials, 9 showed lower results by the test-churn than by the large churn, 5 showed lower results by the test churn, and 2 showed an almost exact agreement. The deficiency in fat was, however, made up for, to a certain extent, by the presence of water in the melted oil, which increases its bulk. That is, there is a balancing of errors. Particulars are given in the bulletin relative to the technique of the test. It was concluded as probable that while the oil-test churn is capable of showing the difference between good and poor cream, it was questionable whether it could make strictly accurate distinctions between different grades of good and poor cream.

Dehorning of Cattle

In the annual report for 1886 Prof. Henry reported on the value of manure from stock on the farm and contributed an article relative to the dehorning of cattle, that subject having been brought prominently before the public by H. H. Haff of Atkinson, McHenry Co., Illinois. Prof. Henry expressed his opinion that instead of being a cruel operation dehorning was a merciful one. The cattle dehorned by means of a carpenter's fine saw did not appear to suffer greatly from the operation, and did not lose a feed or shrink in weight thereby. He reported: "I fully believe we gained over fifty dollars in the operation of cutting off the horns of twelve steers: pretty good pay for an hour's work!" No test of dehorning dairy cows was made, but for bulls and steers it was recommended as a valuable operation and productive of much good.

Feeding for Fat and for Lean

In view of the fact, generally understood at that time, that the bones of hogs were so weak that in many cases their legs are broken in handling on and off the railroad cars, thereby entailing considerable loss, which falls upon the consumer, and suspecting that the incessive feeding of corn was the chief cause Prof. Henry decided to test the matter by experimentation. He thereupon made two lots, of 3 each of cross bred Jersey Red and Poland China hogs for trial. When they were 100 days old he fed Lot I a ration consisting of 1 part dried blood, 6 parts shorts, 14 parts sweet skim milk, by weight, and Lot II all the fine ground corn meal they could clean up. Each lot was freely supplied with water, and exercise allowed in a small yard. The feeding period was 136 days.

The trials showed that when hogs are fed a ration rich in carbohydrates, but lacking in protein, like corn meal, there is an excessive development of fat, not only on the outside of the muscles and beneath the skim, but also among the muscles; that the muscles of the body fail to develop to their normal size, especially those along the back; that an abnormally small amount of hair and a thin skin results; that while the brain, heart and lungs do not seem to change in weight, the spleen, liver and kidneys are unusually small; that the amount of blood in the body is greatly reduced from the normal and that the strength of the bones is reduced one-half. Four well executed colored plates accompanied the text and showed plainly the differences in the proportion of fat to lean meat in the hogs fed, respectively, a protein ration and corn meal alone. Each picture showed the carcass of a dressed hog, laid on its back and cut square across, to expose the fat and muscles in cross section. Three of the hogs illustrated had been fed for fat and three for lean meat.

The experiment, thus graphically illustrated, aroused great interest on the part of farmers,packers and experiment station workers throughtout the country and being reported and favorably commented on by the agricultural press had a valuable educational effect and brought renown to Prof. Henry which grew widespread as further experiments relative to the strength of hogbones were conducted and reported.

In the fourth annual report for 1886, Prof. Armsley by discussed at length on the analyses of feeding stuffs; ~~finding~~ feed value of roller bran; bran compared with corn meal; influence of the nutritive ratio upon milk production; analyses of milk of different breeds of cows, and analyses of fertilizers and other products.

Prof. Woll contributed papers on the methods of butter analysis and notes on Baron Hüll's method of analyzing fats, and Prof. Henry reported tests of machinery. Meteorological observations for 1886-7 were also reported.

Chapter IV.

The Coming of Dr. S. A. Babcock in 1888

The Experiment Station in 1887-1888

The fifth annual report of the Experiment Station, for the year ending June 30, 1888, was of great historic interest. Dr. Thomas Crowder Chamberlain, the noted geologist of Beloit College, had been appointed President of the University. The annual provision of $15,000, provided by the Hatch Act, had been made available, making further progress possible, and Prof. Henry, who had officially been made Director of the Experiment Station, was greatly encouraged.

An event of supreme importance was the arrival of Dr. Stephen Moulton Babcock, of the New York Experiment Station, who commenced work as chemist of the Wisconsin Station in January 1888, Dr. H. P. Arms~~ley~~by having left, the previous autumn to assume the position of Director of the Pennsylvania Agricultural Experiment Station.

Dr. Babcock was born in Bridgewater, N.Y. October 22, 1843 and educated in the local schools. In 1866 he received the A. B. Degree from Tufts College and in 1879 the Doctor's degree from the University of Goettingun, Germany. In 1901 Tufts College honored him with the degree of L.L.D. and in 1917, the University of Wisconsin conferred upon him the degree of D. Sc. He was a member of the staff of the chemistry department of Cornell University, from 1875 to 1882, and chemist of the New York Experiment Station at Geneva from 1882 to 1888. He was a man of charming personality, far seeing vision, inspiring enthusiasm, and plodding perseverance, endowed with the true spirit of scientific inquiry and, with all, simple, democratic, considerate and humble in the extreme. Dr.

Babcock made himself and the Wisconsin Experiment Station famous throughout the world by his discovery and perfecting of the "Babcock Test" for butter-fat which will be described in due course.

In 1888 the department of agricultural physics was also established and was said to be the first of its kind in the world. Prof. Franklin Hiram King, a native of Wisconsin, was appointed head of the department. He came from River Falls High school, where he had been teaching physics. In time he became nationally famous by his admirable work regarding the movements of soil water and especially by his origination of the King system of stable ventilation, which was alopted throughout the country, and in the construction of practical and economical silos. His many notable text books came to be considered standard relative to the various phases of agricultural physics. His fine book on "The Soil" was translated into the Chinese language. Prof. King was a graduate of the Whitewater State Normal school and took graduate work at Cornell University New York, and Johns Hopkins University, Baltimore. The University of Wisconsin honored him with the degree of Doctor of Science in 1910. He died in 1911, when but 63 years old.

During 1888 the Bulletins published were: No 13. "Reports on Crops and the Station Vineyard" No. 14. "Land Plaster" and "Ensilage vs. Fodder Corn for Milk Production."

Crop Growing Experiments

Thirty five varieties of winter wheat were tested on plats containing one-fortieth of an acre each with seed at the rate of 2 bushels per acre. Those for 1887 were sown September 21, 1886. These tests concluded the work with winter wheat, in order that more time might be devoted to the crops which were becoming more commonly grown in the state. Champion Amber wheat produced at the rate of 51 bushels to the acre; Bennet, and Valley, 47 bu.; Zimmerman, and Bearded Treadwell, 46 bu. and Arnold's Gold Medal and German Emperor, 45 bu.

Thirty varieties of oats were sown Apr. 12, on plats of one-thirtieth of an acre each, with seed at the rate of 2½ bu. per acre. Of these the State of North Dakota variety yielded at the rate of 68 bu. per acre. Improved White Russian 64 bu. White Belguim, 62 bu. and Black Champion and White Victoria 57 bu., and White Schonen 56 bu. To date, no variety had been found superior to White Schonen in productiveness, strength of straw and thinness of hull, consequently the variety had become popular throughout the State.

Seven varieties of barley were grown on plats of one-thirtieth of an acre each, the seed being sown April 12, at the rate of 2½ bushels per acre. Mansury again led the list in productiveness with 43 bu. per acre, while the Melon variety failed to repeat its phenominal yield of the previous year.

Of the 15 kinds of corn grown on trial plats in 1887 some scarcely could be considered distinct varieties. All varieties were severely injured by drought. The year's experience failed to develop anything surer or better for the Southern portion of Wisconsin, than Pride of the North and North Star Golden Dent, with the possible exception of Dakota Golden Dent No. 1, grown from seed supplied by W. H. Swartz of Byron, Minn. in 1886, and tested that year with good results.

Some 68 varieties of potatoes were tested. Of the early varieties Early Sunrise, Thorburn and Crane's June Eating were found more desirable. Of medium early sorts, Gen. McClellan, Cook's Superb and Vermont Champion were pronounced very promising and of late varieties Dakota Red, Badger State, Blue Victor and Empire State were recommended for trial.

The Station Vineyard

Start

In 1882 a small vinyard, of about 200 grape vines, was planted and prospered so well that the Station officials felt warranted in recommending grape growing to farmers who would give the vines a reasonable amount of attention. The vineyard was located close to the farm house on a not very favorable soil. It was advised in Bulletin No. 13 that about the middle of October the vines should be bent over, after prunning, and held down by the foot until a couple of shovelsfull of earth had been thrown on top. The vines should then be covered out of sight with more earth to keep them frozen all winter, instead of freezing and thawing as they might if left uncovered. As a result of experience obtained from the Station vineyard, ~~Morries~~ Moore's Early was recommended as preferable, being a grape of fair quality and very early, which was considered of paramount importance for Wisconsin conditions.

After the Moore variety came, in the estimation of Prof. Henry, Worden, Concord, Wilder, and Delaware, in the order named. Through, for shipping, the Worden might be listed last; but for family use it ranked next to Moore's Early.

Fertilizers and Land Plaster

Bulletin 14, published in April 1888 consisted of a general educational article by Dr. Babcock, regarding plant food, how crops grow, how they feed, the composition of plants, nitrogenous plant food, the chemical elements used in the manufacture of artificial fertilizers and the nature and use of land plaster or gypsum. Dr. Babcock also contributed a table of analyses of 14 samples of land plaster, which he had found of good quality, and some of them of exceptional purity. He stated that the difference in their quality might largely be attributed to the amount of moisture which they contained. He said that plaster kept in a damp place will often retain several percent of hydroscopic water, which adds just so much to its weight, and that, before purchasing large quantities of plaster, the farmer should be sure that it has been kept in a dry place, and that it is ground quite fine. A coarse plaster does not dissolve readily and is not as prompt in action. As a rule, light colored plasters are purer than dark colored ones.

Ensilage vs. corn-fodder for Milk Production

Bulletin No. 15, issued May, 1888 gave the results in elaborated fashion of an experiment made by Prof. F. W. A. Woll, in continuation of the work done in the past years by Dr. Arms~~ley~~by. He followed practically the same plan of experimentation and methods of presentation of the results adopted by that scientist.

The experiment was undertaken, not to disprove claims previously made for ensilage, but to ascertain principles. The last years having brought about great changes in the methods of preparing ensilage and largely widened the knowledge of its qualities.

The experiment, in the opinion of Prof. Wall, proved that ensilage, on account of its succulence, has a beneficial influence on butter production, causing a larger part of the milk fat to be recovered in the butter, or causing less waste of butter to occur in the churning. Other results indicated, in brief, that the milk produced during the ensilage period was poorer in composition as regards total solids and casein, while the percentage of fat in the milk was smaller in one case and larger in another than was produced in the corn fodder period; that the quantity of milk decreased during the ensilage periods; that the quantities produced of milk solids, milk fat and casein decreased on the ensilage feed; that there was practically no difference in the nutritive effect of the two rations, only that the ensilage ration produced a somewhat thinner milk; that 12.60 per cent more of fat was churned from the mixed milk of both cows, when the cows were fed on ensilage, than when they received corn fodder, the last week of each period being considered; that the digestibility of the ensilage ration was somewhat higher than that of the corn-fodder rations and that the crude fiber and the protein of sweet corn ensilage appeared to be more digestible than that crude fiber and protein of yellow dent corn-fodder.

Ensilage for Steer Feeding

In November 1887, Prof. Henry tried the affect of ensilage fed to 6 two-year- old and 2 two-year old grade

Shorthorn steers. The experiment began December 2, and ended January 6, running 36 days. The steers were divided into 2 lots of 4 each. One lot was fed ensilage only, while the other lot received ensilage, shelled corn and bran. Water was kept constantly before them. The lot getting ensilage ate only 7,898 lbs. in 36 days. The other lot ate 3,502 lbs. of ensilage, 2, 108 lbs. of shelled corn and 970 lbs. of bran. The ensilage lot gained only 1.5 lbs. daily. The ensilage and grain fed lot gained 3.7 lbs. daily. To make 100 lbs. of gain required, with ensilage only 3,558 lbs. and with ensilage and grain required 654 lbs. of ensilage, 394 lbs. of corn and 181 lbs. of bran. Four hogs, running behind the steers required only 92 lbs. of additional corn to make 100 lbs. of gain. Ensilage fed with a heavy grain ration proved most valuable in effect, and by, having hogs follow the steers, adding only a little more corn, 100 lbs. of gain was had on the steers and 100 lbs. gain on the hogs, 200 lbs. gain in all, for $6.32 or only $3.16 for 100 lbs. of gain.

Shocked and Siloed Corn- Fodder Compared

Feeding tests were made by Professors Henry and Woll in 1887 in a scientific manner on a larger scale to ascertain the loss of nutritive elements of corn fodder on being shocked and stored. Yellow dent fodder corn was used; 21,605 lbs. of it, fresh cut being placed in the silo. The ensilage, as fed to cattle, weighed 14, 538 lbs; besides this, 1,625 lbs. were weighed out as spoiled silage. The fresh cut fodder corn; before being shocked, weighed 17,908 lbs., and as fed out, after having been cured, 4,998 lbs. The fodder lost 20.83 per cent or about one-fifth of its dry matter in shocking, while 31.81 per cent was lost in the siloing process. The greatest loss, in both cases, was of the nitrogen-free extract (sugar and starch mainly) and next to that, of the ash in the shocking, and crude fiber in the siloing process. The average loss, in two trials was found to be, for shocked corn 27.58 per cent of dry matter, and for the fodder cut ~~dent~~ and stored in the silo 26.06 per cent. Prof. Woll, who wrote the report, pointed out that if fodder corn loses more than one-fourth of its value as a food on being shocked in the field for a month and afterward being kept under the most favorable condition, the loss must be far greater when it is left in the field during the entire autumn and winter, subject to the severity of the season, with rain and snow storms. He advised that corn-fodder should be stored under a roof protected from rains, as soon as it is cured, or be cut and filled into a silo as soon as it is wilted.

Prof. Woll also reported, in the fifth annual report of the Station for the year ending June 30, 1888, a comparison of matured dried corn and siloed corn, as regards nutritive value. The samples of mature corn, after shelling, were dried and then thoroughly ground. In the siloed corn, the acidity was determined, and another portion was dried, after being sprinkled with dilute hydrochloric acid to prevent possilbe loss of nitrogen during the drying process. The test showed that the percentage of ash was smaller in the siloed samples in 5 cases, and larger in 3 cases. The percentage of crude protein was, without an exception, lower in the siloed samples than in the matured dried ones, while the starch, sugar, gums etc (nitrogen-free extract) was present, in most cases, in diminished proportions. Amide nitrogen was present in large quantities in the siloed corn. The albuminoids of the corn were found to change during the siloing process into amides, both in the case of fodder corns and the grains themselves. It was found that there was a loss of about 24 per cent of dry matter, falling mainly on the nitrogen-free extract, and next to that on the crude fiber in siloing ears of corn compared with dry matured corn; but the investigation was not intended to ascertain the comparative value of the whole ear of siloed corn and dried corn. It was undertaken to throw light in the change of the grain product in the siloing process.

Prof. Henry in another test, found that ensilage was not eaten with relish by hogs, unless it contains a large amount of ears. Ordinary corn silage was not found satisfactory for swine. Ensilage, fed to sheep, did not, in the small trial made, show definite results. Silage made from dried corn fodder proved unsatisfactory.

When young steers were fed, 17 per cent of the grain was saved by grinding the corn and 6 per cent of the hay; however, when the gain of the hogs following the steers was reckoned and counting pork equal in value to beef, pound for pound, a loss of 12 per cent of the corn and bran was caused by grinding the grain for the steers, when hogs followed. In 1888, when feeding 3-year-old steers averaging 1,333 lbs, 12 per cent of the hay and 9 per cent of the corn and bran was lost by grinding the corn; further more, taking into consideration the gain of the hogs, in the trial made by Prof. Henry, a loss of 53 per cent of the corn and bran occurred by grinding the corn for the steers, when hogs were placed with them.

In experiments conducted the same year, in the feeding of pigs of whole corn compared with corn meal, it was found that corn meal gave the best results with heavy hogs, while whole corn gave the best results with light hogs.

When 6 pigs weighing 734 lbs. running in an open yard and sleeping in a shed, were fed 1 lb. of corn meal to 3 lbs. of sweet skim-milk, it was found that it required 951 lbs. of milk and 317 lbs. of corn meal for each 100 lbs. of gain.

Hogs fed upon dry feed in no case did as well as when fed their feed wet.

Churning Tests

Dr. Babcock, in 1888, made some experiments to determine the difference in the yield and composition of butter churned from sweet and from ripened cream, and also paid attention to other questions having a practical bearing in the making of butter. The experiments were made with cream separated by the Cooley system of deep setting in ice-cold water for 12 hours before skimming. The tests showed that ripening of cream, so far as the yield of butter is concerned results in a very considerable gain, when both sweet and sour cream are handled as nearly as possible in the same way. All of the butter made was of good quality. The gain in quantity of butter from the ripened cream over that churned immediately after skimming, ranged from 14.26 per cent, to 27.54 per cent and averaged 18.98 per cent. There was recovered in the butter made in the tests only 84.66 per cent of the fat. German tests, published by Martiny, show recovery of 93.94 of fat from sour cream. When sweet and sour cream were churned together, in another test, Dr. Babcock, concluded that sweet cream is in no way improved by mixing it with sour cream just before churning. When mixing is done, the cream should be kept at a room temperature of 60° to 70° F. with occasional stirring, for at least 12 hours before churning. The most economical results, however, were obtained when the cream from each milking was churned by itself. The same increase in the yield of butter produced by ripening the cream, may be obtained by adding about one-fourth per cent of lactic acid to sweet cream just before churning.

Determining Fat in Milk

In 1888 F.G. Short, described in the fifth annual report and in Bulletin No. 16, a new method for determining fat in milk. The process was based on the following facts, when a mixture of milk and a strong alkali is heated to the temperature of boiling water for a sufficient time, the fat of the milk unites with the alkali and forms a soap which is dissolved in the hot liquid. At the same time the casein and albumen are disintegrated and become much more easily soluble. After heating for about 2 hours, the mixture becomes homogenous and of a dark brown color. On the addition of an acid the soap is decomposed and the fatty acids are set free and rise to the surface, while the albumen, casein, etc, are first precipitated and then dissolved. The insoluble fatty acids, thus obtained, constitute very nearly 87 per cent of the total fat in the milk. Directions for making the test were given. The process was intended for commercial analysis, rather than the extreme accuracy called for in scientific work.

Results obtained by the new method compared closely with those obtained by gravimetric analysis. The new process is also applicable to the analysis of cream, by taking certain precautions advised. It was not claimed as an accurate method of analyzing milk containing under one-half per cent of fat, but will show any watering or skimming of milk down to that point.

Notes ~~in~~ on forage plants by F.G. Short were also published in the fifth annual report and he also reported on the effect of dehorning milk cows on the production of milk, butter and the weight of the animals. The 12 cows dehorned showed a slight falling off in milk yield, an increase in fat, and for a few days, a slight increase in body temperature. No serious loss in body weight was caused; neither did dehorning lessen appetite for feed.

Leslie H. Adams, superintendent of the Station farm furnished an illustrated plan for a hog house which contained several novel and practical features.

Bulletin No. 17. published in November 1888 reported on tests of varieties of corn, oats, barley and potatoes similar to those of previous years, and a second illustrated report on grape growing.

The concluding article in the fifth annual report of the Station was that on the composition of feed stuffs by Prof. F.W.A. Woll. It presented information on the chemical constituents of food and furnished tables showing the average composition of various feeding stuffs, feeding standards and examples showing how the tables should be used in composing balanced rations for live stock.

Following the custom of the last three reports, a summary of the meterological observations latter at the Washburn Observatory, Madison was presented in the fifth annual report, with tables corrected and brought up to the close of 1887.

Prof. Goff, Horticulturist Appointed

In the sixth annual report of the Experiment Station, covering the period from July 1st, 1888, to June 30th, 1889, the appointment of Prof. Emmet Stuff Goff, of the New York Experiment Station, Geneva, secured April 1, 1889, was announced. He was employed to take charge of the horticultural work of the Station and give instruction in horticulture. Prof. Goff was born on a form near Elmira, N.Y. September 13, 1852. He graduated from Almira Free Academy in 1869, and then took advanced studies at the Geneva, New York, experiment station and University of Wisconsin. In time he became well known as an advocate of spraying fruit trees, his first important work being a study of the apple scab fungus, and the testing of various fungicides for the control of that disease. His investigations in regard to the formation of flower buds also attracted wide attention from horticulturists and botanists alike. His text books on the principles of plant culture, lessons in pomology, and first principles of agriculture, became standard in their field. The manuscript of the last named book was practically complete at the time of his death, and was completed by Prof. Mayne. His portrait graces the picture gallery in Agricultural Hall of the College of Agriculture. His only son, Moulton Babcock Goff is, today, a successful fruit grower at Sturgeon Bay, Wisconsin.

The resignation of Chemist F.G. Short also occurred during 1888 after a service of five years and was greatly regretted, as he had done admirable work in his specialty. His ingenious test for butter-fat in milk was the most notable of his accomplishments and led, in certain respects, to the famous discovery of the Babcock milk test. On leaving the Wisconsin Experiment Station he became chemist to the State Food and Dairy Commission at Madison.

Relative to work done in 1888 the bulletins published, in addition to Nos. 16 and 17 already mentioned, included, No. 18. of January 1889, in which Dr. Babcock gave an account of important experiments he had conducted relative to the constitution of milk, and some of the conditions which affect the separation of cream. Some of the conclusions arrived at were: that milk when fresh is a perfect emulsion, the fat globules being free and without an envelope; that variations in the amount of fat cause the chief difference in the composition of normal milks, while the milk serum is uniform in all milks; that the variation in the amount of serum solids, in milk from the same cow, is rarely more than one per cent, in milk from different cows of the same breed is usually less than one per cent; and, in milk from cows of different breeds, not more than two and one-half per cent; this holding true even when the fat varies as much as seven or eight per cent; that milk contains a principle analogous to, or identical with blood fibrin, which is capable of spontaneous coagulation, the clots of which entangle the fat globules and to a considerable extent prevent an efficient creaming; that most efficient creaming is obtained by setting the milk in ice- cold water directly after milking, and that when the milk is transported, or when for any reason the setting must be delayed, no method of creaming gives as satisfactory results as the centrifugal.

In his introduction to Bulletin No. 19, of April 1889, by L. H. Adams, concerning ensilage, Prof. Henry stated that there were, at that time probably 2,000 silos in Wisconsin. He also said that the ensilage made in 1888 at the station was much superior to that of former years and gave good results when fed. The Bulletin mentioned gave advice regarding the location, form and method of building a silo, how to paint the inside walls, handle the fodder corn, the length it should be cut, use of a chute, method of filling the silo, and placing two crops in the same silo.

In Bulletin No. 19, F. G. Short also reported on a test of several varieties of corn, changes in the silo and feeding rations. It was found that while the large rank growing B.& W. and Fargo Bros. Ensilage, while giving in one case 5,000 and the other 6,000 pounds more green fodder to the acre, gave no more nutritive matter than Smedley, a yellow dent of the Pride of the North type, suitable for northern Illinois, but a little too large and late for a general field crop in the Madison district. Prof. Short also brought out the new and correct conclusion regarding ensilage that, besides having a greater feeding value, corn that has been allowed to mature to the point of glazing has, in flint corn and well dented in the dent corns, nearly twice as much nutritive matter to the ton, as that cut when the ears are first beginning to show the tassel. It was his opinion, also, that too much cannot be said in favor of clover for the silo; but for placing in it the silo clover should be allowed to become more mature, cut when the dew is off, and that, in filling, the clover should be evenly distributed, and well tramped down in the corners, and along the sides. Clover so handled makes bright, sweet, palatable ensilage, that is eagerly eaten by cattle, and forms a valuable addition to their rations.

Experiments in Pig Feeding

The energies of the Station's workers during the year from July 1, 1888 to June 30, 1889, were largely devoted to animal husbandry. Prof. Henry busied himself with pig feeding, having become intensely interested in the affects of various feeding materials on the animal body. The first experiment he reported for the year was made to determine the effects of dried blood, pea meal and corn meal on the carcass, bones and viscera of the hog. He found that when pigs were fed corn meal alone, 483 lbs. were required to make a gain of 100 lbs. of live body weight in one lot of pigs, and 478 lbs. in the other; as compared with 407 lbs. and 410 lbs. for hogs fed one-third dried blood and two-thirds corn meal, and 462 lbs. and 435 lbs. for the pigs fed one-half pea meal and one-half corn meal. The corn meal ration was cheapest, but a greater weight of it was required for producing 100 lbs. of gain than of the other two mixtures. At butchering time the viscera and blood of each animal were weighed separately. The total weight of the blood from the blood fed hogs was greatest, that from the corn fed hogs was lowest. Comparing the weights of the livers, to the dressed weight of the carcass, there was a difference against the corn-fed hogs of over 19 per cent; for the blood-fed, and 16 per cent for the pea-fed hogs. The same falling off in the total weight was noted in the kidneys from dried blood-fed, compared with corn-fed hogs, as occurred with the blood and liver. There was nearly 2 per cent more fat in the kidneys of the corn fed hogs than in the kidneys of the other two lots. A difference of 7.6 lbs. of lean meat per 100 lbs. of carcass was found in favor of blood and pea-fed hogs, or 40 per cent more lean meat than in the carcass of the corn-fed hogs.

A test to ascertain the effects of rain-water, well-water and bone-meal on the growth of carcass and strength of bones of pigs seemed to show that there was no advantage in supplying well-water as compared with rain-water. Indeed, the results were against well-water in the amount of gain made, the food required for 100 lbs. of gain, and the breaking strength of the bones. Feeding ground bone seemed to have greatly strengthened the bones of the pigs receiving it. As the last mentioned experiment was not conclusive, another was made on a modified plan. One lot of pigs was fed corn meal, ground bone, salt and rain-water; a second lot corn meal, hard wood ashes, salt and rain-water, and a third lot cornmeal, salt and rain-water. The results showed much stronger bones in the hogs fed ground bone or wood ashes and corn meal compared with those fed corn only. There was almost twice the amount of ash in the bones of the hogs fed bone meal or wood ashes. More than 50 lbs. of corn meal was saved by adding bone meal or wood ashes to the ration, in making 100 lbs. of gain in live weight. The bone meal and ashes did not, however, build up the red meat of the body more than in those fed exclusively on corn meal. Whole oats, compared with ground oats, as a feed for hog, in 4 separate feeding trials, or 16 in all, of 30 days each, indicated the poorest results from a ration composed of two-thirds whole oats, and one-third corn meal. The next poorest result was obtained where one-third whole oats were fed with two-thirds of corn meal. Where two-thirds of the ration consisted of ground oats, with one-third corn meal, there was 100 lbs. gain from 429 lbs. of feed supplied, as the average for 4 trials. Where whole oats were fed there was a saving of 76 lbs. on 568 lbs. by cutting down the oats of the ration from two-thirds to one-third, and substituting corn meal for the oats. Where the ration contained one-third ground oats and two thirds corn meal, the average of 4 trials showed that only 403 lbs. of feed were required for 100 lbs. of gain. Prof. Henry concluded that oats are just as valuable for building bone and muscle in a pig as in a colt.

A test of skim-milk for mature, as compared with growing hogs, given in addition to corn meal for 63 days, made a gain of 193 lbs. for the mature hogs, and 164 lbs. for the immature pigs. To gain 100 lbs. the mature hogs ate 1430 lbs. of skim milk and 301 lbs. of corn meal, and the growing pigs 1024 lbs. of skim milk and 174 lbs. of corn meal.

Trials of feeding pigs before and after weaning, proved that it pays to feed sows when suckling pigs so heavily that they will gain in weight; for the cost of the gain made by the pigs and their dam is than cheaper than the gain of the same pigs when grown. Some sows, however, give so much more milk than they can offset by consuming and digesting feed, that they rapidly lose weight while suckling pigs.

Repeated examination showed that the total length of the intestines of the hog range from over 18 times to nearly 25 times the length of the body. The wonderfully increased length of the intestines in the modern improved hog may reasonably be taken to indicate that the power of the digestive apparatus has been greatly increased.

The relation between the weight of hogs, gain made, and food required for 100 lbs. of gain, was also given by Prof. Henry in the form of tables based upon over 100 feeding trials, with over 300 hogs, ranging in weight from under 50 to over 300 lbs. The tables were followed by an instructive paper giving practical suggestions on hog raising. In the latter, the concluding paragraph emphasized the importance of feeding ashes to hogs, and recommended those of burned corn-cobs to aid in building up the bones of hogs.

Yield and Quality of Milk

Dr. Babcock contributed several interesting conclusions regarding cows' milk in the sixth annual report, for 1889. They had to do with variations in the yield and quality of milk, milking one teat at a time, milking fast and slow, change of milkers, milking tubes vs. hand milking, change of cows' quarters, and the effects of dehorning upon the composition of milk.

From his experiments Dr. Babcock concluded that the elaboration of milk is most active at the time of milking, and is dependent both upon the stimulus of the milking act, and the nervous condition of the cow. Slight changes in the conditions under which milking is done may materially influence both the yield and quality of milk. As a general rule the quality of milk, measured by the per cent of fat it contains, is more sensitive to changes of this kind, than is the yield of milk. There is a decided difference in the quality of milk from the different teats when milked one at a time but the average of each teat, for the first four milkings, independent of the order of milking, shows that so much of the difference has disappeared that it is doubtful whether there is any real difference in the physiological functions of the different quarters of the udder. The average yield of milk was slightly in favor of fast milking. The yields of both milk and fat were quite uniform; but that of the cows milked slow was a little less than when there were milked fast. Change of milkers caused more change in the quality, than in the quantity of milk yielded. The greatest effect was noticed, at the first milking, after the change was made. The manner of milking may account for variations in the yield of milk.

The time required for milking all four teats at the same time, with milking tubes, was not much different from that required by hand. On the whole, the yield of milk was slightly less than when the cow was milked by hand. The quality of milk was invariably poorer when the tubes were used than when the cow was milked by hand and the quantity of milk also was less. Change of quarters at first caused a considerably reduction in milk yield; but this was more than offset by an improvement on the following days, so that, in the aggregate, there appeared no actual loss from change of place. That was also practically true of the temporary loss in milk yield caused by the dehorning operation. Dr. Babcock expressed the opinion based upon his experience, that kind treatment and pleasant surroundings for cows will have a greater influence upon the quality of their milk than the kind of food, provided that the ration given contains sufficient nutriment for the maintenance of the cow.

Digestion Experiments with Corn Silage and Corn Fodder

Two experiments conducted by Prof. Woll proved that the milk decreased on fodder corn feeding, as did also the total daily production of milk solids, fat and casein. Ensilage feeds proved more nourishing. The churning qualities of the milk fat did not seem to be influenced materially by the feed. While the number of fat globules in the milk decreased, and their relative size increased on the fodder corn feed. As in previous experiments, the ensilage rations were slightly more digestible than the fodder corn ration. In another experiment of like kind the churning qualities of milk were improved with 4 per cent, while the fat globules increased in numbers and decreased in size on ensilage feed. A similar effect was found in a previous experiment. It was further found, in both experiments, that with the advance of the period of lactation of the cows, the number of fat globules increase, at the same time as they are growing constantly smaller in size.

In illustrated Bulletin No. 20, of July 1889, Prof. E. S. Goff described some of the common noxious weeds of Wisconsin, and suggested practical methods for their destruction. The bulletin also contained a synopsis of Chapter 432, Laws of 1889, relating to the destruction of noxious weeds.

Warm or Cold Water for Cows

Whether drinking water for dairy cows should be warmed in winter, was being asked by dairymen, therefore, Prof. King experimented to settle the question, and in Bulletin No. 24, of October 1889, published the results. Six cows, in groups of 3 each, were used for the test which began January 21 and ended March 25. The time of the experiment was divided into 3 periods of 16 days each, having intervals between them. At the close of the first and second periods the temperatures of the water were reversed for each of the cows to eliminate, so far as possible, the individual differences of the 2 groups. The temperatures of the water, for one group, was 32° F., and for the other group, 70° F. The ration fed the 2 groups was identical and adequate.

The tests showed that the cows on warm water gave on an average 1.002 lbs. of milk per cow per day, more than while on cold water, or 6.23 per cent of the general average daily yield of 16.06 lbs. The cows drank on the average, daily, while on cold water, 63.lbs., and on warm water 73 lbs., or 10 lbs. per cow more. An increase of 10 lbs. in every 100 lbs. of water drank, whether warm or cold, was accompanied by an increase of 1 lb. of milk, in about every 100 lbs. yielded. The cows consumed solid food at the rate of 1.44 lbs. for each pound of milk produced, while on warm water, and 1.54 lbs. while on cold water, With one exception, the cows on cold water weighed more at the end of the experiment; but with 3 exceptions, they weighed less at the close of the warm water periods. It was figured that 40 cows on warm water, for 120 days, would show a net gain of $21.36, averaging 16 lbs. of milk per cow, per day. When butter brought 20 cent per pound, skim milk was worth 25¢ per 100 lbs, corn fodder was worth worth $5.00 per ton and the cost of warming the water was placed at $15 for 40 cows. Counting corn fodder at $10 per ton, the net gain, on a herd of 40 cows, would still be $12.48.

Bulletin No. 22 of January 1890 contained a report by L. H. Adams, on oats and barley tests in 1889, and by Prof. Goff on potatoes for that year. White Sehoren oats and Mansury barley led the list in productiveness and other good qualities. While in the potato tests Rose Beauty was the best seedling tried and Alexander's Prolific best in quality for table use. Heavy, rather than light seeding was advised. Cutting of the "seed end" of the tuber was found detrimental. No advantage resulted from sprinkling the cuttings with plaster before planting.

Soil Physics

In the sixth annual report, for 1889, Prof. King published the results of his first work relating to soil water. His tests indicated that tooth-like disc harrows and curved tooth harrows cutting comparatively deep groves in the soil tend to dry the ground rapidly and deeply. Plows and cultivators which leave a loose layer of soil on the surface tend to diminish loss of soil moisture from below by capillary action and evaporation. Deep plowing in spring, especially on heavy soils, and where much coarse material is turned under, tends to produce a deficiency of moisture for shallow rooted plants, unless heavy rains occur; and for deeply rooted plants during the early part of the season, by partially cutting off the water supply at a depth below the roots. Shallow plowing or surface stirring tends to diminish surface evaporation and favor rising of water by capillary action to the roots of young and shallow rooted plants. Fall plowing and early spring surface cultivation tend to draw water and minerals in solution to the surface, thus concentrating them there for later use by plants. Much loss by under-drainage is thus prevented.

Prof. Woll grew prickly comfrey and experimented with it as a fodder crop in comparison with red clover. The prickly comfrey was second year's growth white green, and yielded at the rate of nearly 34 tons to the acre compared with about 26 tons of green clover per acre. The highest percentage of dry matter in any of the cuttings of prickly comfrey was 14.38. Only 8.22 per cent of the total weight of the first crop of clover was dry matter; but in three cuttings, the clover yielded more dry matter and protein than the prickly comfrey in four, 23 and 25 per cent more respectively. The cows did not relish prickly comfrey and did not take it when anything else was offered. It did not compare in value as a cattle food with red clover looking at both forage plants from the standpoint of the general farmer.

Prof. Short found that when hay is left out only four days after cutting, and exposed to a rain, a loss of over 4.5 per cent of dry matter, and over 3.5 per cent of protein occurred. The palatability of the hay was also impaired.

L. H. Adams offered an illustrated plan for a floor and watering trough for the cow stable, and Prof. Woll furnished an instructive paper on the composition of feeding stuffs.

Death of Hon. Hiram Smith.. 1890

The seventh annual report, for the year ending June 30, 1890 announced the death on May 15, 1890, of Hon. Hiram Smith who, for 12 years, had acted efficiently as chairman of the Farm Committee of the Board of Regents. Prof. Henry said of him: "To work under the direction of this man was a constant enjoyment, and an ever present stimulus." He had helped most ably to bring the Experiment Station to a position of high rank. The Wisconsin Farmers' Institutes came as an outgrowth of his thought. While practically self-made, he did not worship his maker. No cultured graduate of a college could quite as well have done what he did in stirring the dormant mental energies of his class. His farm had been a practical experiment station, doing gratuitous and valuable work for every person who kept a cow. The State Dairyman's Association was one of his monuments. He was a friend of young men, and age did not numb the touch of his sympathies. He lived long enough to see the first dairy school in the United States established at the University of Wisconsin under his direction. He will be ever be honored for he had "the love of wisdom and the wisdom of love."

Prevention of Apple Scab

Prof. Goff advised, in Bulletin 23 of April 1890, on prevention of apple scab, that the causal fungous parasite also affects the leaves and new growth of the tree, and that the spores, blown about by the wind, lodge upon the leaves, fruit and young shoots, germinate, and thus propagate the disease. Experiments with various fungicides were conducted during the season. The cost of making them was borne by the U. S. Department of Agriculture. Trees were sprayed with a solution of potassium sulphide, and others with a solution of soda hyposulphite, or with a solution of one and one-eighth ounces of carbonate of copper in a quart of ammonia, diluted with 90 parts of water. A solution of lime-sulphur was also tried. All of the treatments proved more or less beneficial, and the carbonate of copper solution was almost a complete remedy for the disease. Three or four sprayings with a force pump, were recommended, one of them to be applied just before the leaves open.

Chapter V.

The Babcock Milk Test Announced

July 1890

Announcement of the Babcock Milk Test

In Bulletin No. 24, published in July, 1890, Dr. S. M. Babcock announced his discovery of a "new method for the estimation of fat in milk, especially adapted to creameries and cheese factors" which was to become world-known and used, as the "Babcock Milk Test."

Immediately after becoming chemist of the Experiment Station, in 1888, Dr. Babcock began experimenting to find a simple, entirely satisfactory and practical method of determining the percentage of butter fat in milk. A number of methods had been proposed, including the ingenious one reported by Prof. Short, but they had proved too expensive, and took too much time, though substantially correct in their findings. Dr. Babcock, in the introduction to the first report of his discovery, said with characteristic modesty, "In the test described in this Bulletin, it is believed that some progress has been made in simplicity and economy, without sacrificing the accuracy of the results. Whether this test will find a place among those already introduced time alone can decide", and "time" did decide that it was, and has remained, the one and only standard test for fat in milk.

The new test followed the development of the practical method of separating the cream from bulk raw milk by the application of centrifugal force, perfected by Dr. DeLaval, of Sweden. These two discoveries practically revolutionized commercial dairying and buttermaking. The Babcock test also benefitted the cheese-making industry. Prof. Henry reported that over 60,000 copies of bulletins and reports describing the new test, were issued by the Wisconsin Experiment Station, and that many other stations had published similar descriptions. At home and abroad, newspapers and farm journals also gave the test wide publicity. "It is believed," wrote Dean Henry, "that the Babcock milk test is the means of saving in each creamery in Wisconsin, where used -- and it is universally used --- not less than two-tenths of one per cent of all the butter fat delivered by the patrons to the creameries. In other words, without the test this amount of fat would be wasted through poorer separation and poorer churning. The Babcock test checks up the separator and the churn, so that there is no need of losing an appreciable amount of fat at any time, while these losses would steadily occur, were the operator not continually apprised of the conditions by the use of the test. The Babcock test is used wherever dairying is practiced throughout the civilized world, and the name of its inventor is spoken as frequently in Australia and New Zealand as it is in Wisconsin."

Dr. Babcock also gave dairy breeders a basis of breeding for production which made possible much of the development achieved in the improvement of the five great dairy breeds of cattle, and he likewise devised scientific ways of doing things, in other particulars, that enabled research workers to progress in all branches of dairy chemistry. He refused to patent his invention although, had he done so, he might have become a multimillionaire. However, the world would not consent to have him remain wholly unacknowledged. The legislature of Wisconsin, in 1899, voted him a large bronze, commemorative medal, made in London, England, as an expression of appreciation, and it was formally presented in

1901. Tokens of esteem and admiration also came to him from many parts of the world, and he received the "Grand Prize" from the World Fairs of Paris, France and St. Louis, Missouri. In 1917 the University of Wisconsin honored Dr. Babcock with the degree of Doctor of Science.

Technique of the Test

To make the test, a sample of well mixed fresh milk is carefully placed by means of a pipette in a graduated bottle made for the purpose. Then 17.5 cc. of commercial sulphuric acid, which is approximately the same amount as that of the milk, is carefully poured into the test bottle of milk and being heavier it sinks to the bottom. The milk and acid are then thoroughly mixed by shaking. A large amount of heat is evolved by the chemical action of the acid upon the milk, and the solution, at first nearly colorless, soon changes to a very dark brown. Upon standing a short time the fat begins to collect upon the surface. When all of the samples have been prepared in the way mentioned, the test bottles are placed in a centrifugal machine, such as was illustrated by Dr. Babcock in Bulletin 24, and which, when whirled by hand or power, makes from 600 to 800 revolutions per minute. The bottles are then whirled for 6 or 7 minutes, or longer, if the machine is less than 20 inches in diameter. The milk in the bottles is kept heated to not over the boiling point of water while in the machine; this being accomplished by means of a water jacket under which there is a burner or kerosene stove. When the bottles have been sufficiently whirled, they are filled to the neck with hot water. The cover of the machine is then replaced, and the bottles are again whirled for one or two minutes; after which more hot water is added, filling the tubes of the test bottles to about the 7 per cent mark. More twirling is then done, while the water in the tank is kept hot. When the bottles are removed from the machine, and held in a perpendicular position, the column of separated fat in the tube of the bottle is clearly separated from the acid liquid by a line between it and the fat. The tester then notes the divisions of the scale on the tube, or neck of the bottle, which mark the highest and lowest limits of the fat. The difference between these gives the percent of fat. The readings can easily be taken to half divisions or to one-tenth per cent. The bottles used must be accurately made, as furnished by reputable firms. The expense of the machine and tests is comparatively small.

Feeding Experiments

In the annual report for 1890 accounts were given of several preliminary experiments in stock-feeding. Prof. Henry fed both whole and skim milk to lambs, in conjunction with concentrates and green feed and in comparison with milk for pigs. Lambs about 10 days old were fed whole milk alone from a bottle 4 times daily for 21 days. Each lamb gained nearly half a pound daily, at which rate it would require 579 lbs. of full milk for 100 lbs. of gain. Lambs fed skim milk, oats, green clover and green corn fodder gained at the rate of nearly half a pound daily. The conclusion was that if lambs can be taught to drink milk as do pigs they should be able to comsume it on dairy farms with satisfaction and profit.

When ewes and lambs were fed cut green feed and oats in a yard, instead of grazing them, the ewes gained one-tenth of a pound daily and the lambs one-third of a pound in a 57-day trial.

Wether lambs fattened best and at least cost on a ration in which corn silage and fodder were fed along with hulled corn. A ration composed of oil meal and oats, clover silage and clover hay produced the least gain, but at the greatest expense. Silage proved a most satisfactory feed, regulating the bowels and enabling the lambs to make a very satisfactory gain for food consumed." The best gains were made with the grains that cost the least.

Prof. Woll conducted two experiments with 6 cows for the study of the comparative nutritive value of ground oats and bran for milk and butter production. He found that with a ration of 10 lbs. per day and per head, of ground oats or of bran , fed in connection with the same ration otherwise, there was a ten per cent greater yield of milk and milk fat on oats, than on bran; but at the prices prevailing in 1890, bran was the more economical feed for milk cows.

Composition of Milk

Dr. Babcock determined the amount of fat in nearly 300 samples of milk and presented a table giving the maximum, minimum and average per cents in milk from different localities. Eleven herds averaged under 3 per cent and 53 herds over 4 per cent. The maximum in the state was 5.75 per cent, minimum 2.34, and average 3.68.

Effects of Rolling Ground

Experiments by Prof. King showed that rolling land increases the temperature of the soil, and increases its power for drawing water to the surface, but induces more rapid evaporation of moisture than from unrolled land; unless the surface soil is very wet, when the reverse is true. The drying effect of rolling was found to extend to a depth of 4 feet. Broadcast seed germinated quicker and more completely on rolled than on unrolled ground. The size of the kernels of oats was larger on rolled than on unrolled ground, and the weight per bushel greater.

Prof. King also gave an elaborate report relative to his studies of soil moisture, and furnished an illustrated plan and description for a round dairy farm barn. The barn was built in the spring of 1889 on the farm of C. E. King, near Whitewater, Wis. It contained a silo in the center and had many ventilating flues which insured a supply of fresh air coming to all animals alike, while the impure air was drawn out in a uniform sheet all around the silo. The round barn was considered economical in construction, as it combined everything under a single roof by adoption of the cylindrical form "which requires the smallest amount of siding, roofing and paint, and which admits of the cheapest and least lumber for the frame, and by distributing the lumber so as to make it perform two or more functions". It also saved considerable time in feeding and caring for the animals housed. Prof. King asserted that "in any case where an octagonal barn is desired, the circular type will always be found cheaper and more stable."

Prof. Goff determined by careful tests that the hulled grains of timothy seed neither germinate so well nor retain their vitality so long as those not hulled; also that timothy seed, when properly stored, is fairly reliable up to 5 years old.

Chapter VI.

Animal Husbandry

Under Prof. John A. Craig

in 1891

Hiram Smith Hall

In the eighth annual report, for the year ending June 30, 1891, Prof. Henry announced that a generous appropriation had been made by the legislature for the erection of needed buildings, and that a dairy school building, to be known as Hiram Smith hall, was to be built forthwith. The first floor was, if possible, to be ready by the beginning of the year 1892. The building, of which a picture appeared in the report, was planned for dairy investigation purposes as well as dairy instruction.

Although the bulletin announcing the Babcock milk test was only issued July, 1890, several firms were reported to be manufacturing the apparatus for the test, and interest in it had become widespread. Relative to the test Prof. Henry said "I believe that even yet, none of us fully appreciate its value to the dairy interest. I fully believe that the test is worth to Wisconsin each yearmany times the whole cost of the experiment station.

Live Stock Work
Begun by Prof. John A. Craig

A considerable amount of space was given in the 8th annual report for 1890-1891 to an account of the sheep investigations conducted by Professor John A. Craig, a graduate of the Ontario Agricultural College, who had been placed in charge of the work, it being believed that next to her dairy interests Wisconsin should foster sheep husbandry. Prof. Craig was well qualified for the work he was called to undertake. He had the honor of being the first head of the first purely live stock department at an Experiment Station, and was destined to institute new methods of research and introduce practical methods of teaching live stock judging based upon the principle that an accurate and scientific knowledge of animals can be acquired only from a well-directed study of the live animals.

Prof. Craig was born on a farm near Winchester, Ontario, Canada, December 25, 1868, and was educated in the district school, the Ontario Agricultural College, and the University of Toronto. After graduation, he filled an editorial position, in 1889, with the Canadian Live Stock Journal, ~~with~~ which he left in 1890 to assume his work at the University of Wisconsin. One of his first enterprises in Wisconsin was the inauguration of live stock judging contests which were the first of the kind in this country. His feeding experiments at Wisconsin were also the initial ones in this line. In 1896 he resigned and joined the animal industry staff of Iowa State College. While there he brought out, in 1901, his notable testbook on judging live stock, and it at once becam the standard work on the subject and has run through many editions. In 1899 he conducted the first students' competitive livestock judging contests between Agricultural Colleges, at the Trans-Mississippi Exposition, at Omaha. In 1901 he retired from Experiment Station work and became editor of the Iowa Homestead af Des Moines. His health failing there, he moved to a farm at Rice Lake, Wisconsin, in 1902, but the climate there proved too severe and he moved to San Antonio, Texas, where he established his Oakmore Farm. His health having improved in the milder climate of the southwest, he felt able to resume college work and in 1903 became Dean dnd Director of the Texas Agricultural and Mechanical College and Experiment Station. Resigning that position in 1906 he returned to his farm and remained there until 1908 when he accepted a position with the Oklahoma Agricultural College, which he filled until 1910, when, his health again failing, he resigned and returned to his farm, where he died August 9, 1910. John A. Craig was frail in body, but truly great in heart and head. He was loved and esteemed by a host of friends and admirers and will be remembered, and honored in memory, as one of the great, constructive animal husbandry pioneers and leaders of his day.

The practical work of the sheep feeding and breeding experiments, inaugurated by Prof. Craig, was done with scrupulous care and integrity by Frank Kleinheinz, a native of Bavaria, Germany, whom Prof. Henry had engaged as shepherd in 1889. He had learned shepherding on his father's farm, and in his care the station flocks prospered and, in later years, proved almost invincible in the showyards. Craig and Kleinheinz made a "working team" that quickly popularized the sheep industry of the state and helped to make it profitable for the breeders. Mr. Kleinheinz became known as the "Dean of the University Shepherds". In 1902 he was made assistant, in 1905, instructor, and in 1916, assistant professor of animal husbandry. University sheep, fitted and exhibited by him at the International Live Stock Exposition, Chicago, won many honors in competition with flocks from other agricultural experiment stations of the country, and those of many sheep breeders of the United States and Canada. From 1900 to 1927 his winnings approximated $18,000 in cash prizes, and his sheep also won many medals and trophies, and a number of scholarships for students. In the first 14 years of showing he won grand championship carcass prize at the "International" 10 times, and again in 1925, the carcass of the lamb that year selling for $8.00 per pound, netting $424 for the animal. His practical book on sheep management became the standard text on that subject. The Wisconsin Dog Law resulted from his efforts and he was highly regarded as an instructor and renowned throughout the country as a fitter, exhibitor and judge of sheep.

During 1891, John Wright Decker, of Neenah, Wisconsin, who had received the degree of Bachelor of Science in agriculture from the University of Wisconsin in 1890, was made an instructor in dairying. For eight years he was the chief cheese maker in the station dairy and also taught cheese making to the short course dairy students. He was the author of "Cheddar Cheese Making", which became a standard text and was translated into French and extensively used in Canada. In the autumn of 1899 he was called to Ohio State University as Associate Professor of Dairying. When in service there he published a second book entitled "Milk and Its Products", and introduced the making of Swiss and Edam cheese. In the spring of 1897 he had studied dairy methods in Denmark, Holland, the Channel Islands and Great Britain, which helped him materially in his work in Wisconsin and Ohio. He was with the University of Wisconsin exhibit at the Columbian World's Fair at Chicago, and installed the Ohio State University exhibit at the Buffalo, N. Y., exposition.

Minerals for Hogs

In October, 1890, Bulletin No. 25 was issued, in which Prof. Henry gave the results of another test of bone meal and hard wood ashes fed to hogs living on corn. It showed that the effect of bonemeal and ashes was to save about 130 lbs. of corn, or 28 per cent of the total amount fed in producing 100 lbs of gain, live weight. Bonemeal also doubled the strength of the thigh bones, and hard wood ashes nearly had the same effect. There was about 50 per cent more ash in the bones of the hogs receiving bonemeal and hardwood ashes than in hogs otherwise fed.

Sheep Feeding Trials

Prof. John A. Craig reported the results of feeding breeding ewes, experimentally, in comparison, winter rations of hay, corn fodder, oat straw, corn silage and sugar beets. Cut corn fodder, of the dry fodders, gave the best results, maintaining the ewes cheaply, in good health, with fleeces in good condition, and abundant milk at lambing time. Oat straw proved better feed for ewes than was expected, so that it might be more largely used with other fodders. While hay is a good dry fodder for sheep closest economy would give the preference to oat straw and corn fodder. Corn silage proved valuable for breeding ewes, surpassing other succulent fodders tested in its cheapness, and by keeping the animals in thriving condition, and inducing a good flow of milk. Clover silage, properly preserved, also proved good for sheep and was eaten with relish after the sheep became used to it. Sugar beets were well-liked, but were not equal to either kind of silage mentioned. Cheaper gain was made by wethers fed a carbonaceous ration of whole corn, cut corn fodder and corn silage, than by wethers fed a nitrogenous ration composed of oats and oil meal mixed equally, by weight, clover hay and clover silage. The latter gained 214 lbs. during the test period, compared with 181 lbs. for the lot fed a carbonaceous ration.

Shearing wethers in winter, before fattening them, showed that the unshorn animals made a greater and cheaper total gain than the shorn wethers. The unshorn wethers also gave the greater gain in wool and mutton combined, at least cost. Feeding grain to lambs, while suckling, showed that the best results are derived from feeding grain as soon as the lambs relish it, which is usually when they are 2 to 3 weeks old.

Tests of the effects of crossing various breeds of sheep showed that, in nearly every instance, the peculiar features of a breed, such as the Merino, are merged in the first cross sheep.

Prof. King tested the effect of imperfect ventilation upon milk cows. The cows drank an average of 11.4 lbs more water each day, under the conditions of poor ventilation. There was a difference of 6.3 degrees F. in the mean temperature of the stable under the good and poorly ventilated periods. In all cases, the mean weight of the herd increased under the conditions of good ventilation, while under the reverse condition there was a loss of an average of 10.75 pounds in weight per cow. The amounts of feed consumed under good and poor ventilation conditions were practically the same. In a second test, covering a total period of 122 days, in 2 equal periods, it was found that, of the 60 pairs of days, there were 33 when more milk was given by the cows with the ventilators open, and 26 days when more was given with them shut, there being a balance of 119.7

lbs. in favor of the best ventilation, or an average of nearly 1 lb. per day for the whole period. Considering that 25 cows occupied a space in which, ordinarily, nearly twice that number would be housed, and that the cows were turned out of doors daily, and that the ventilators were closed only 12 hours in each 48 hours, and one ventilator 12' by 16" always open, Prof. King was surprised that any effect whatever was indicated.

Additional experiments relative to the effects of rolling spring plowed land were conducted by Prof. King in 1890-91. It was found that with both oats and barley drilled in, there was a much smaller germination on the rolled ground, whereas the results the previous season, in every one of 8 cases of broadcast seeding, were the reverse. The yield of barley per acre was increased when the land was rolled and harrowed. Oats on land similarly treated showed a larger amount of dry matter per acre than when simply drilled in.

Continuing his experiments relative to soil moisture, Prof. King found corroboration of his previous conclusions, and came to the additional conclusion that under conditions of good cultivation, corn may draw, in considerable quantities, upon soil water existing at depths greater than 7 feet below the surface.

Prof. Goff reported the results of strawberry and raspberry tests. Of strawberries, Warfield No. 2 produced best, and continued bearing as long as any other. Of the raspberries tested, Thompson's Early Prolific and Gladstone proved most satisfactory. Breeding experiments with tomatoes were also made, and showed that for the Wisconsin climate growing the plants on rather poor and dry soil, pinching the growing plants, or root pruning, by retarding rampant growth, enhanced productiveness and early maturity. The health of the plants depended much upon the quality of the seed used. Popular demand for cheap seeds tended to deteriorate the quality of seed offered, while the plants grown from them were more subject to disease. In no way was the use of immature seed sanctioned or recommended. Prof. Goff again experimented with fungicides for apple scab, and found that in seasons of excessive rains the scab on badly infested trees cannot wholly be prevented by use of copper carbonate-ammonia solution, sulphur powder solution, or the compound copper sulphate-ammonium carbonate solution. Fruit on a badly infested tree may be so lessened in size as to diminish the crop nearly 20 per cent, which, doubtless, is but a small part of the injury actually produced. At least one spraying, previous to the opening of the flowers, was recommended; but sprayings after midsummer were, at best, considered of doubtful value. Prof. Goff also furnished an illustrated paper on a new method of applying kerosene for the destruction of insect pests, notes on cut worms, a new preventive against the cabbage maggot, and reports of experiments in spraying against the aphis. An emulsion of kerosene and soap was almost entirely successful at the time of the swelling of the buds of the apple tree, but was ineffective on the apple and viburnum, after the buds had opened.

The Station Sheep Barn

The erection of a building for the accommodation of sheep at the station was commenced in the autumn of 1889, and important additions were made in 1891. An illustrated description of the building, by L. H. Adams, was published in the eighth annual report for 1891. Some of its features were considered worthy of use in the barns and sheep stables of the practical sheep breeder, although they were arranged with special reference to the experimental work of the station.

Chemical compounds for preventing the growth of horns on cattle were also discussed in an illustrated article by L. H. Adams, in the eighth annual report. He did not find the application of caustics painless, as claimed in advertisements of the chemical fluids used. He advised that the fluid so far as possible shoupd be applied to very young calves, since the older the calf grows the more it seems to suffer from the treatment.

Total Solids and Specific Gravity of Milk

The annual report for 1890-91 closed with a report by Dr. Babcock, regarding the composition and specific gravity of milk. Several formulae had been proposed as aids in determining the composition of milk when its specific gravity and the per cent of either total solids or fat were known. The new, simple Babcock method of determining the per cent of fat in milk made it preferable to base the formulae upon a determination of the fat instead of upon the total solids of milk. The report explained how the Fleischmann formula for such a determination should be used. Elaborate tables were given for use in the procedure. A simpler formula, used in the dairy school of the University of Wisconsin during the past two winters, was then explained, and instructions were also given for the determination of the specific gravity of milk by means of the lactometer.

Sugar Beet Culture

Investigations were made at the station in 1890 relative to sugar beets for the production of sugar. The work was done under the general direction of the U. S. Department of Agriculture, which also gave financial aid. Secretary of Agriculture J. M. Rusk was sponsor for the experiment, and the results were announced by Prof. Henry in Bulletin No. 26, issued in January, 1891. The investigations were conducted by Prof. Woll. The experiments were conducted at five sub-stations in Wisconsin and at the Experiment Station.

The six varieties of sugar beets grown at the station were found to contain from 14.81 to 10.76 per cent of sugar in the juice, the coefficient of purity ranging from 82.2 to 86.3 per cent. About half an acre of each variety was grown, and the yield of washed beets varied with the different varieties from 16 to 26 tons per acre. The estimated yield of sugar varied from 2 to 3½ tons per acre, about 80 per cent of which would be recovered as pure granulated sugar in a well-managed factory. It cost from 84 cents to $1.38 to grow, harvest and deliver a ton of beets. At the sub-stations the beets grown ranged in sugar content of the juice from 12.21 to 17.14 per cent, while the beets averaged at the rate of 4 tons per acre in St. Croix county where wet cold weather retarded growth to nearly 39 tons per acre in Waukesha county, where all conditions were favorable. The results of the investigations were considered highly satisfactory and encouraged the belief that Wisconsin is well adapted to sugar beet culture.

Feeding Value of Whey

Four trials were conducted at the station during the autumn and winter of 1890-91, to ascertain the value of sweet whey for pig feeding. The results were reported by Prof. Henry in Bulletin No. 27, published April, 1891. He found that pigs couldn't successfully be maintained on whey alone. Pigs fed corn-meal and shorts ~~shoots~~ with water required 552 lbs. of the mixture for 100 lbs. of gain. Whey whey was added to the mixture it produced a marked saving in the amount of grain required for good gains. This was true for mixtures varying from 2 lbs. of whey to 1 of grain, up to 10 lbs. of whey to 1 of grain. When whey was used as a partial substitute for grain, 760 lbs. of whey effected a saving of 100 lbs. of the corn meal and shorts ~~shoots~~ mixture. Pfof. Henry advised that shorts ~~shoots~~, pea meal, and oil meal, or like feeds, should be mixed with whey for growing pigs. Some corn may be fed at all times, the proportion increasing as the animal approaches maturity.

Dairy and Horticultural Physics Buildings Erected

In the ninth annual report for the year ending June 30, 1892, in which Charles Kendall Adams had become president of the University, Director Henry drew particular attention to the notable work being done by Prof. Craig in sheep feeding, and by Prof. Woll in dairy cow feeding. He reported, also, that students had flocked to the station by hundreds for instruction in the use of the Babcock milk test, and that the second bulletin on the subject was nearly exhausted. The work of Prof. King, in agricultural physics, was also commended, and it was announced that the horticultural department had at last found a permanent home.

The first dairy school in the United States had been established in January, 1890, in a small one-story building which in 1881 had been built on the university farm at a cost of $500. It contained a small room for making butter, and another for an ice house. In 1889, this building was enlarged by the expenditure of about $100, and in it the dairy school opened with two students in attendance. Next year there were 70 students, with several applicants turned away for lack of room. The crowded condition of the little building was brought to the attention of the legislature of 1891, and they gave the university, for 6 years, one-tenth of a mill tax on the assessed value of the property of the state, for building purposes, and provided that a commodious dairy building should be erected. Out of this fund so provided Hiram Smith Hall (Dairy) was completed in 1892 at a cost of $35,000 for the building and equipment.

In 1893, the legislature appropriated $14,200 for a horticultural building. The regents, finding this amount inadequate, made provisions for a large building, and the joint Horticultural-Physics building was erected on the south slope of Observatory Hill, at an outlay of $34,000 for the building and equipment.

It was also announced, in the ninth annual report, that Prof. Goff had planted an experimental orchard on the northern slope of Observatory Hill, and had used promising varieties of hardy fruits for the purpose.

Reference was likewise made to the work being done to aid growers in fighting potato diseases, fruit tree fungus pests, and noxious insects.

Prof. Henry also expressed the opinion that "the production of all the sugar consumed by the people of Wisconsin is one of the greatest problems now before us," and that anything that could be done by the Experiment Station to assist in the matter would be cheerfully undertaken. He acknowledged, too, with much pleasure, the receipt of a fine life-size bust crayon portrait of Hiram Smith, from his daughter.

Construction of Silos

With a view to obviating further difficulties in the construction of silos, and of suggesting remedies for the defects of existing ones, Prof. King made a study, in 1891, of the actual construction and condition of silos in use at that time, The results of his investigations were published in Bulletin No. 28, of July, 1891. Of 93 silos examined, 70 were in Wisconsin, 6 in Michigan, 6 in Ohio, and 11 in Illinois. Of these, 67 were lined wholly or partly with wood, 10 were lathed, and plastered with water-lime, while 14 were of stone, grout or brick, with cement facing, two lined with metal, and one with tarred paper. Plans of 3 types of silos were given, with a statement of the cost of each. Suggestions were also given relative to the repair of existing silos.

Creaming Experiments

To compare the efficiency of the deep setting and centrifugal methods of creaming milk, Dr. Babcock conducted a series of experiments which were reported in Bulletin No. 29, of October, 1891. Incidentally, the effect of delay in setting, the use of ice, and other questions were studied. It was found that, in skimming by the Cooley system, the syphon should be set so as to leave at least one inch of skim-milk with the cream. The efficiency of creaming by deep setting was greatly influenced by the character of the herd, the milk from some herds creaming very close, while that from other herds, under the same conditions, creamed poorly. Delay in setting caused varying losses in different herds tested. To avoid the occurrence of such losses, it was recommended that milk be set as soon as possible after milking.

Deep setting of milk, where the temperature of the water was not lower than 50 degrees F., caused an excessive loss, reaching as much, in some cases, as 25 per cent of the total fat in the milk. The centrifugal system of separating cream overcame all of these difficulties, giving an efficient creaming, with milk from all sources, either directly after milking, or after standing several hours.

Further Sugar Beet Experiments

The question of sugar beet culture in Wisconsin having been studied for 3 years, Prof. Woll, in Bulletin No. 30, of January, 1891, reported further tests of varieties at the station, and presented tables showing the result of the analysis of beets from farmers in different parts of Wisconsin. The 11 varieties of beets grown at the University farm during the season of 1891, contained from 14.99 to 20.53 per cent of sugar in the juice, and the average yield of wash beets per acre, was 14,677 lbs.. Severe drought

the richest being 23.52 per cent, and the poorest 7.12 per cent. The average of all analyses was 12.56 per cent of sugar in the juice, and the average estimated yield of beets per acre, was 15 tons. The investigations showed that Wisconsin is in the beet sugar belt. Farmers were advised to continue raising sugar beets, that the establishment of beet sugar factories might, in time, be warranted.

Use of the Babcock Test

Dr. Babcock, in Bulletin No. 31, of April, 1892, stated that his milk test, first described in Bulletin No. 24 of the Wisconsin Station, had been quite generally adopted by dairymen and breeders. The edition of Bulletin No. 24 having been practically exhausted, and a few precautions having either been overlooked or not made sufficiently clear in it, a second bulletin describing the method again, with fuller information regarding the making of the test, and the manner of using it in creameries and cheese factories, seemed advisable. The new bulletin (No. 31), served the purposes and was again widely distributed.

In addition to the information previously published, and with some clearer explanations, Dr. Babcock recommended for factories having a large number of patrons the method of using the composite test proposed by Prof. E. H. Farrington, chemist of the Illinois Experiment Station. That test consisted in the addition to the three-fourths of a quart of soured milk which comprises the composite sample, about one-half a teaspoonful of concentrated or powdered lye, such as is sold by grocers for making soap. By the action of this concentrated alkali the acid of the sour milk is neutralized and the curd dissolved, so that by pouring the milk from one jar to another it soon becomes completely mixed and can be successfully tested.

Dr. Babcock also gave directions for the detection of adulterations in milk, and the use of the lactometer.

As it had been maintained by many feeders that the practice of siloing corn "ears and all" was a waste of food material, and that silage from corn with the ears removed would go as far as silage from corn with the ears left on, Prof. Woll decided to determine the economy of the two kinds of silage. He therefore experimented with Pride of the North corn. The cows fed ate 17 tons of silage with ears in it, and nearly 14 tons of silage with the ears removed, plus 2 tons of earn corn, in addition to a fundamental ration of hay, oats, and ~~shoots~~ shorts. They drank $1\frac{1}{2}$ lbs. less water per day, and weighed 3.5 lbs. less while on silage with ears in it, than when on the other ration. The product of milk was 411.6 lbs. larger, and of butter fat 16.5 lbs. larger during the period in which the cows ate silage from corn siloed "ears and all". Prof. Woll concluded that the cheapest and most convenient way to preserve the whole corn crop is to fill it directly into the silo.

Physics Experiments

Pfof. King continued the soil moisture experiments he began in 1891-2 with the addition of red clover and field peas, to determine the amount of water required to produce a pound of dry matter in such crops. The results pointed strongly toward the conclusion that there is rarely water enough in our soils, under natural conditions, to realize even approximate possible returns from the land, and that irrigation, where possible in times of deficient moisture, would insure much larger average yield from the crops grown.

Additional experiments by Prof. King to determine the influence of deep and shallow cultivation on the water content of the soil, showed that thorough cultivation greatly diminishes surface evaporation from the soil, and keeps the soil below the surface cooler, thus strengthening capillary power to retain moisture where needed by the roots of plants. It makes more water available for plant use. His continued experiments relative to the influence of farm yard manure on the movement and amount of water in soil showed that during the season of 1891-2, which had been wet, farm yard manure had a much less marked influence upon the water content of the soil than was shown during the dryer season of the previous year. The results showed a measurable influence of the farmyard manure in leaving the soil at the end of the season more moist than without its application, and this, too, down to a depth of 4 feet at least.

Prof. King also began a series of studies to determine, and illustrate, the extent and manner of root penetration and development in field soils under normal conditions of tillage. He published, in the ninth annual report of the station, a number of instructive photographs showing the development of corn roots at various stages of growth, and like pictures showing the root developments of wheat, barley, oats, blue grass, timothy, Lathyrus silvestris, and clover. The clover, blue grass, and barley were grown on clay loam; the timothy, winter wheat, and lathyrus silvestris were grown upon higher, heavier soil. The blue grass grew much the shortest roots, being only about 26 inches long, while in each of the other plants the roots were nearly 4 feet long.

In the ninth annual report Prof. King also gave an elaborate, complex and highly technical illustrated account of his observations and experiments on the fluctuations in the level and rate of movement of ground-water on the Experiment Station farm and at Whitewater, Wisconsin. The expenses of the investigation were borne conjointly by the U. S. Department of Agriculture, Weather Bureau, and Wisconsin Experiment Station. The article referred to was also published as Bulletin No. 5, of the Weather Bureau.

Chapter VII.

Bacteriology Department Established
Under Dr. H. L. Russell
in 1893.

Bacteriology Department Established

The tenth annual report of the station, for the year from July, 1892, to June 30, 1893, was composed chiefly of summaries of the nine annual reports previously issued, as these were now practically unavailable.

The past year had been one of marked progress for the Experiment Station. The most important happening was the addition of the department of bacteriology, under the direction of Dr. Harry L. Russell. That scientist began his work September 1, 1893, with a well-equipped laboratory and library located in the rooms formerly used by Prof. Goff for the horticultural department. The new horticultural building, with its two greenhouses attached, was now complete, and was in use for students for the first time in January, 1894.

Dr. Russell, a native of Wisconsin, and a graduate of its university in 1888, had taken his master's degree there in 1890 and in 1893 obtained the doctor's degree at Johns Hopkins University, after having done post-graduate work under Dr. Robert Koch, the famous German bacteriologist. He had also studied in the laboratory of the great Dr. Louis Pasteur, in Paris, and, for a time, in Naples. He was thus eminently well-fitted for the work he undertook at the university and which quickly made him famous in Wisconsin and throughout the country. He had brought a supply of tuberculin from Koch's laboratory and was the first to use it, by testing the University herd of dairy cows. He was, therefore, the pioneer in this line ~~fo~~ of work, and for many years ably directed a successful fight against bovine tuberculosis in Wisconsin and encouraged similar campaigns in other states. He likewise did other notable work, in cooperation with Dr. Babcock, which will be mentioned in the notes on his various bulletins.

During the year, 4 bulletins were published, of which the first was that by Prof. Craig on lamb feeding.

Feeding Grain to Lambs

Prof. John A. Craig conducted some experiments reported in Bulletin No. 32, of July, 1893, to determine the preferable method of feeding grain to lambs. He found it profitable to feed the lambs, before they are weaned, all the grain they will eat, while on good pasture with their dams, corroborating the conclusion arrived at from a previous trial. It did not pay, however, to feed grain to the ewes when on good pasture, if they had been properly fed in winter so as to be in good condition at lambing time. Feeding lambs a mixture of oil meal and corn meal gave better results than a mixture of cotton ~~and~~ seed meal and corn meal. During the 10 weeks of trial the lambs given the oil meal ration made a weekly gain of 3.30 lbs., while those getting the cotton seed ration made a weekly gain of 2.95 lbs. The oil meal ration was, in addition, cheaper.

Dairy Cow Rations

During the spring of 1893, Prof. Woll asked reports from a number of dairymen and breeders in Wisconsin, relative to the rations they had given their dairy cows during the preceding winter. In Bulletin No. 33 of October, 1893, he presented extracts from the reports received. The various rations were published, with a statement for each of the cost and the chemical constituents of the feeds mentioned. The average yield of milk per year, for the herds reporting, was 5,806 lbs. per cow, and of butter 291 lbs. per cow; which was considered a remarkably good showing, considering that the average yield of butter per cow, for Wisconsin, is usually placed at 125 lbs. per year. As a result of his investigation, Prof. Woll advised dairymen to keep only cows that respond to good feeding; feed liberally, but not to waste; select such feed stuffs as will supply a fair quantity of protein; raise and feed more oats and clover; use bran, ~~shoots~~ shorts and oil meal, whenever needed; and when obtainable at a reasonable price.

Preventive Treatment of Plant Diseases

During 1892, Prof. Goff vigorously continued his campaign against apple scab, downy mildew and brown rot of the grape, potato blight, and the smut of wheat and oats.

The results of his work were given in Bulletin No. 34 of January, 1893. He estimated that the damage from oats smut alone, in Wisconsin, must have amounted to one million dollars, and set the loss from potato blight at the same figure. The damage from apple scab in the norhtern states, in 1890, was estimated at six million dollars. Thanks to the investigations of the past few years, however, Prof. Goff and other scientists had learned to prevent, in ~~just~~ great measure, by timely treatments, several of the most common diseases of plants, and they felt justified in recommending those treatments to farmers and fruit growers. The bulletin mentioned ~~their~~ then offered information and instructions relative to spraying technique, the Bordeaux mixture, annomiacal carbonate of copper, and how to prefent and control apple scab, downy mildew and brown rot of the grape, and smut of potatoes. Illustrations of loose smut of oats, and stinking smut of wheat, were given, together with instructions for the application of the Jansen hot water treatment for these pests. Tests had shown that the hot water treatment not only prevents smut, but causes an increased yield of grain.

Cranberry Pests

In Bulletin No. 35 of April, 1893, Prof. Goff furnished illustrated information regarding insects and diseases injurious to the cranberry. The insects described were the black-headed cranberry worm, which had been especially destructive in New Jersey, and the yellow-headed cranberry worm. Preventive measures, such as flooding with water, and use of kerosene emulsion, were recommended. Similar information was given relative to the cranberry fruit worm, the tip worm, and scale insect. The cranberry span worm, destructive in Massachusetts, was reported as having attacked wild cranberries in Wisconsin marshes. The cranberry diseases discussed were fall fungus, and scald. Instructions relative to spraying against destructive insects followed.

Irrigation Investigations

During the fiscal year ending June 30, 1894, investigations in irrigation for garden and farm crops were conducted at the Experiment Station. For the purpose, Professors King and Goff used a 10 horse-power steam engine and boiler, a large centrifugal and a small rotary pump, a cement reservoir, 40 feet in diameter, and a considerable length of piping. In the autumn, 10 acres of marshland on the station farm, a small portion of it actually below the level of Lake Mendota, was fitted for farming, by a system of diking, drainage and pumping. A 14-foot Eclipse windmill, working an 8 by 10 inch cylinder pump, with a direct stroke, was used to lift the water out of the reservoir, over the dike and into the lake.

The station herd having been tuberculin tested by Dr. Russell and Dr. W. G. Clark, instructor in veterinary science, and nearly all of the cows found tuberculous, so that they had to be slaughtered, legislative assistance was to be asked for the purchase of a new dairy herd and a new barn to replace the one that was badly infected. Dr. Russell reported on the test in Bulletin No. 40, which will be reviewed in due course.

Much of the time of Dr. Babcock had been devoted to work relative to his new milk test, and that connected with the dairy test of the World's Columbian Exposition at Chicago. Prof. Wall had been busy in the editing and general supervision of the station report and bulletins, and caring for the agricultural library. For these reasons, the amount of chemical research work for the season was less than usual.

From July, 1893, to June 30, 1894, 4 bulletins were issued and are reviewed in the following paragraphs.

Babcock Test Literature

The demand for the publications of 1890 and 1891 describing the Babcock milk test had been so great that the editions were soon exhausted. Bulletin No. 31, of April, 1893, giving fuller information, and comprising 10,000 copies, had been distributed by 1893 and Dr. Babcock, therefore, found it necessary to issue Bulletin No. 36, in July, 1893, again fully describing the test, and repeating information previously published regarding the detection of adulterations in milk, and use of the lactometer.

The Russian Thistle

As the Russian thistle had invaded Wisconsin from the westward and was proving a noxious weed, Prof. Goff, in Bulletin No. 37, of October, 1893, advised farmers to stamp it out before it had secured a strong foothold. He explained that the Russian thistle, or Russian "cactus", is neither a thistle nor a cactus, but that it is a saltwort, closely related to the tumbleweed, goosefoot, lamb's quarters, and pigweed. A description of the weed followed, with information relative to its noxious nature, origin, modes of distribution, areas covered, conditions favorable and unfavorable to its growth, and remedies. Plates showing the appearance of the plant when the seeds are mature, and before flowering, accompanied the text. One of the remedies recommended by Prof. Goff was pasturing by sheep which relish the weed before its growth becomes coarse and woody. Thoroughly cultivated crops of corn, potatoes, beets, or any well cultivated crop will, he stated, rid land of not only the Russian thistle but nearly all other weeds.

Dairy Cow Rations

As the results obtained from an investigation of Wisconsin methods of feeding dairy cows, made in the spring of 1893 and reported in Bulletin No. 33, had proved of considerable importance and practical value, Prof. Woll continued the investigation on a broader scale during 1893 and published the results in Bulletin No. 38, of January, 1894. One hundred American winter rations for dairy cows, with data regarding them, were listed in tabulated form, together with tables showing the components of the rations and a discussion of the results obtained.

Noxious Weeds

The act relating to the destruction of noxious weeds having been amended in 1893, Prof. Goff published in Bulletin No. 39, of April, 1894, the full text of the law. The Canada thistle, sow thistle and the Russian thistle,"a trio of enemies that may well cause farmers to think seriously, if not to shudder", had been vigorously pushing their campaign of conquest, making a greater fight agains them imperatige. Farmers were, therefore, urged to enforce the weed law and no longer permit the pests to flourish through indifference or negligence. General instructions for the suppression of noxious weeds were given; then followed a description, with admirable illustrations, of the Canada thistle, burdock, ox-eye daisy, snap-dragon, cocklebur, sow thistle, sour or yellow dock, wild mustard, wild parsnip, sweet clover, and Russian thistle.

Swine Feeding Experiments

In the eleventh annual report Prof. Henry published the results of further work he had done in swine feeding. His trials showed that Berkshire and Poland China pigs, used for breeding purposes, after reaching a weight of about 100 lbs, can be carried up to a weight of over 300 lbs.on feeds which favor and promote bone and muscle growth, with a requirement of about 500 lbs. of meal or meal equivalent for each 100 lbs. of increase in live weight. Cottonseed meal and linseed meal, as a partial food for pigs, were tested. No deleterious effects were noticed from feeding a very small allowance of cottonseed meal. It was known that cottonseed meal fed in large quantities for an extended period invariably causes fetal poisoning in swine, but Prof. Henry thought it probable that where not over one-quarter of a pound of such meal is fed daily for each 100 lbs. of body weight of the pig, injurious effects would be unlikely. He found that for 100 lbs. of gain, live weight, it required 492 lbs. of meal or its equivalent, with the pigs getting cottonseed meal, and 516 lbs. of meal or its equivalent, with the pigs getting oil meal.

Prof. Henry again made thorough tests to determine the relative value of cooked and uncooked feed for swine. The trials showed a little advantage from cooking feed. The general average from 5 trials showed that 439 lbs. of meal, after cooking, were required for 100 lbs. increase live weight, while 454 lbs. of uncooked feed produced the same result. As the result of three trials it was found that for 100 lbs increase, live weight, more wheat meal was required than of a mixture half wheat and half corn meal. Pigeon-grass seed meal was found to compare favorably with wheat meal as a feed for hogs.

In 1894, Prof. Craig again found rape satisfactory in every way for feeding sheep and in the eleventh annual report again gave instructions for its cultivation and use. He also made further tests of the effect of fall shearing and found it a beneficial practice to prepare lambs that are 6 months old for the early winter market. It should be done not later than October. For late winter fattening and sale he considered fall shearing of no practical advantage.

Prof. Woll experimented with 12 cows, in 1893, to determine the comparative feeding value of linseed meal, corn meal and wheat bran for dairy cows. There was practically no difference in the immediate effect of the cornmeal and the wheat bran on the yield of milk, and a small difference in favor of oil meal. In the production of fat, both oilmeal and bran gave somewhat better results than corn meal. Given a good, fairly nitrogenous basal ration, an addition of wheat bran or corn meal, at the prices then prevailing, would be, in the opinion of Prof. Woll, "in the line of economy rather than the feeding of oilmeal".

Dairy Experiments

Dr. Babcock presented a resumé of the results of experiments in the manufacture of cheese and quoted some of those obtained at the New York Agricultural Experiment Station. The data given pertained to the influence of fat upon the yield and quality of cheese; the yield in factories, from different qualities of milk, at different seasons of the year; loss of cheese in curing, and cleaning milk, with a centrifugal cream separator for cheese production.

Dr. Russell discussed the sources of bacterial infection and their relation to the keeping quality of milk. He advised that just so far as bacterial organisms, taints, and offensive fermentations can be kept out of milk will depend its keeping qualities. Not only must milk be secured and handled with scrupulous cleanliness after it is drawn from the cow, but the care of the animal and her surroundings must be of such a nature as to diminish to the greatest extent the possibility of contamination to the milk at the time of milking. The milk must also be stored at the lowest possible temperature.

A preliminary experiment was made by Dr. Russell to determine the relation of separator slime to tuberculosis in hogs. While negative in its results as concerned tuberculosis, it showed that the slime from the creamery tested, when fed to swine, did not prove infective.

Tests of Dairy Cows

As many breeders and agricultural associations had requested that tests of cows be made by station experts, J. W. Decker of the dairy department undertook the work. Over 90 tests, varying in length from 1 to 7 days, were made. It was concluded, from the tests, that the quality of milk improves but little, if at all, as the cows grow older, and that the same cow may show great variations in the quantity and quality of her milk from day to day. While it was found that there is less difference between tests at fairs and at home, than has been claimed, a cow may become so fatigued that she will not do her normal work. Excitement may increase the fat in milk, as well as diminish it. Individuality is a great factor in determining a cow's value, and no one breed can claim all the good cows.

The effect of salt upon cheese was also tested by J. W. Decker. He found, by analysis, that the cheese from salted curds contained less moisture than that from the unsalted, the difference being sufficient to account for the difference in yield. The cheese contained practically no salt other than that added; the salt originally in the milk being mostly lost in the whey. The salt retained by the cheese is not proportional to the amount added to the curd. Heavier salting of the curd showed practically the same results. Increasing the amount of salt made the cheese cure more slowly, and up to about 3 lbs. of salt per 100 lbs. of curd cheese, induced better texture and flavor.

From August 26 to October 18, 1893, Prof. Woll microscopically examined fat globules of the milk from pure bred cows of herds competing in the dairy tests at the World's Columbian Exposition in Chicago. The milk of individual cows was also examined. Tables published in the eleventh annual report of the station showed the results. The average size of the fat globules was largest with the Jersey cows, next with the Guernseys, and last with the shorthorns. In the heifer test, on the other hand, the shorthorns had the larger average fat globules.

Experiments in Agricultural Physics

In 1893-4 Prof. King made tests to measure the amount of water required to produce a crop of potatoes at the station farm. The number of inches of water required for a ton of dry matter of potatoes, counting simply that added and the rainfall, was, for the surface irrigated land, 16.70 in.; for the not irrigated land, 8.15 in., and for the sub-irrigated, 21.87 in. The field tests plainly indicated that the water added had a very beneficial effect upon the potato crop, the surface irrigated yield being 51.7 per cent greater than that on the not irrigated check plots, and the sub-irrigated yield 34.2 per cent greater, while on a gravelly knoll the watered area gave 108.4 per cent more than did its control plot.

A similar test to determine the amount of water needed by growing oats was held. The general average of 7 trials was 557.3 lbs. of water for 1 pound of dry matter. The tests served to emphasize the point previously made by Prof. King that the oat crop so depletes the soil of water that it is difficult to obtain a catch of clover sown with it when the season is a dry one.

Prof. King also made observations on the rate of percolation of water from a system of tile drains on the station farm, and from sub-irrigation tile. He also tested the influence of the water pumped, on the yield of crops growing on the sub-irrigated area.

During four consecutive seasons Prof. King likewise experimented to determine the best depth of stirring the soil in the cultivation of corn. Of 20 trials, 14 were in favor of 3 inch cultivation, and 5 in favor of 1.5 inches, while in the others the yields were equal.

Work of the Horticulturist

Continuing his experiments in strawberry culture, Prof. Goff found nothing to equal the Warfield, as a general purpose strawberry. In the summer he made arrangements for irrigating the small fruit grounds with water from Lake Mendota. The first irrigation was done June 11, just as the fruit, was beginning to ripen, no rain having fallen since May 23. Effects of this 18 days of drought were becoming apparent, but immediately after irrigation the plants resumed their fresh and vigorous appearance, and yielded a fine crop of excellent fruit. The area left unirrigated gave a poor return of fruit. Additional irrigation was necessary on June 12 and 16 and August 17. The irrigated plants made a vigorous growth and remained green when severe drought, later in the season, nearly ruined the not irrigated plants. Other experiments emphasized the importance of procuring strawberry plants and seeds of vigorous and healthy parentage. No definite results were obtained by spraying strawberry plants with Bordeaux mixture against blight. Prof. Goff concluded that the most satisfactory preventive of blight is to burn over the strawberry bed after the berry season, thus destroying all diseased leaves, and then to provide abundant water to stimulate a vigorous new growth.

Prof. Goff's report for 1893-4 included notes on the recently introduced ornamental trees and shrubs. He announced, too, that the last trees of the apple orchard, previously planted on the experiment station farm, having been removed to make room for the new dairy school building, trees for a new orchard had been planted on the north slope adjacent to the horticultural building.

Culture and Curing of Tobacco

During the winter of 1892-3, the legislature appropriated $800 for two years to be used at the Wisconsin Experiment Station for experiments in growing and curing tobacco. The experiments were begun by Prof. Goff in the spring of 1893. A small curing-house was erected, in which the tobacco from one and one-half acres was hung and cured. In the season of 1894, a crop was also grown and cured from a somewhat larger area than that of the previous year. An account of the work was published in the eleventh annual report of the station.

From experience gained, Prof. Goff concluded that the curing of tobacco is probably rather a process of elimination of water ~~wastes~~ than one of drying. Green tobacco loses about 71 per cent of its weight during the curing process. The changes in color of tobacco leaves, during the curing process, results from certain changes within the leaves. Riper tobacco yields a lighter color of cured leaf than that which is less mature. It should be cured in as moist an atmosphere as possible. Use of the psychrometer instrument enables one to anticipate danger from pole-burn. A wet bulb depression of not less than one degree, nor more than two degrees, should be maintained by careful attention to ventilation. The curing house should be so constructed that air entrance may be under control, and should be provided with a stove for heating the air in wet weather. The plants should be hung at uniform distances in the curing house and so distributed as not to leave open spaces from the bottom of the building to the top.

From the field experiments with tobacco Prof. Goff learned that closer planting in the row was followed by a marked increase in yield, and a thinner leaf. Lessening the distance between the rows had no such effect. A distance of 3 feet and 7 inches between the rows was sufficient for the full development of the tobacco plants.

The Twelfth Annual Report

This report, for the fiscal year from July 1, 1894 to June 30, 1895, was issued in 1896, and announced that the legislature of 1895 had appropriated $20,000 for the completion of the Agricultural-Physics wing of the joint Horticultural-Physics building, $5,000 for a dairy barn, and $2,000 for the purchase of a herd of dairy cows to replace the herd slaughtered on account of tuberculosis.

During the summer of 1895 Prof. King visited Europe to study irrigation in humid regions. The University Creamery entered its second year of continuous operation in April, 1895. The legislature of 1895 passed a law placing the control of all fertilizers selling at $10.00 a ton, or more, in the Experiment Station. The legislature also directed Prof. Henry to investigate cut-over regions in northern Wisconsin, prepare an illustrated handbook of not over 200 pages on the subject, and have 50,000 copies printed for gratuitous distribution.

In July, 1894, Edward Holyoke Farrington, a native of the state of Maine, came to the Wisconsin Experiment Station as head of the dairy department, after having served as chemist of the Illinois Experiment Station from 1890 to 1894. He had been chemist of the Connecticut Experiment Station - the first station established in America - from 1882 to 1888, and was with the office of experiment stations of the U. S. Department of Agriculture from 1889 to 1890.

In 1882, he was one of the first chemists at the first sewage experiment station, started at Lawrence, Mass., by the Mass. State Board of Health, under Hiram F. Mills. In 1893 he had charge of the laboratory and records of 75 cows in the 120 days of Dairy cow testing at the World's Columbian Exposition in Chicago, Ill., and in 1903 had full charge of the testing and records of the Dairy Tests at the St. Louis, Mo., World's Fair. His text books "Testing Milk and Its Products" (with Prof. Woll) and "A Guide to Quality in Dairy Products", became standard works on those subjects, and are still so considered. That on testing milk has gone through 27 editions. The high water mark of his Wisconsin dairy school management was one year in which instruction was given to 923 students, and the university dairy did a business of over $200,000 in the manufacture and sale of dairy products. Prof. Farrington obtained his B. S. and M. S. degrees from the University of Maine. His research achievements at the Wisconsin Experiment Station were many and notable, and will be mentioned in summaries of his station bulletins. He retired, with the honorary title of Emeritus Professor, in 1927.

Chapter VIII.

The Campaign Against
Bovine Tuberculosis.

Tuberculosis and the Tuberculin Test

Dr. H. L. Russell, who had begun his work at the experiment station September 1, 1893, made his presence there nationally known by the publication of his historic Bulletin No. 40, of July, 1894, in which he graphically told the story of bovine tuberculosis and his initial experience with the tuberculin test. His account began with informative statements regarding to the prevalence of consumption in man, and then told of the ravages it makes among cattle. The nature of Koch's tuberculin, or "lymph", was next explained, its action upon living animal tissues described, and detailed instructions given for its use as a diagnostic agent.

A veritable sensation was made throughout Wisconsin and America by the account which followed relative to the results of Dr. Russell's application of the test to the cows composing the experiment station herd. A few of the animals were tested, primarily as a demonstration to students of the value of the test; but such a large percentage were found affected with tuberculosis that it was deemed advisable to make a complete and thorough study of the subject. The entire station herd was then tested, with the assistance of Dr. W. G. Clark, instructor in veterinary science; Dr. W. S. Miller, instructor in anatomy in the university, also materially aided in several instances. Some of the tuberculin used was that prepared under Koch's formula. Later the U. S. Bureau of Animal Industry prepared tuberculin which was extensively used by boards of health and some experiment stations for experimental purposes. Not enough imported tuberculin was available for use on the entire herd, but double inoculations were made with a part of the herd and showed interesting results, though the dose of imported tuberculin used was less than that usually employed.

Of the 30 animals tested, 22 proved tuberculous. Of the 18 animals chosen for the comparison of the domestic and imported brands of tuberculin, 9 were infected with the bureau fluid and 6 reacted, while of the remainder, tested with imported tuberculin, 6 were diagnosed as tuberculous. Of the young stock tested with the imported lymph, 9 out of 11 reacted. Tables accompanied the text showing the temperatures of the animals of the herd before and after the injection of tuberculin, and comparing the results of physical examination and the post-mortem lesions. A careful physical examination of the 18 animals used in the comparative tests, previous to the first inoculation, was made by Dr. Clark. In only two cases did he find marked symptoms positively indicative of tuberculosis, while two others showed less marked symptoms, and four were accounted suspicious. Dr. Russell concluded that "The superiority of the Koch test over a physical examination was thus demonstrated beyond all doubt".

This notable work in tuberculin testing at the Wisconsin Experiment Station inaugurated the campaign against bovine tuberculosis which later became nation-wide and gradually was to eliminate the disease in America.

Grain Feeding of Lambs

Prof. Craig continued his lamb feeding experiments during 1893-4, and reported the results in Bulletin No. 41, of August, 1894. Pictures of some of the animals used in the tests accompanied the text. The feeding of grain to lambs before weaning produced an average of 61 cents per head more profit, at weaning time, than that obtained from the lambs given no grain. The average of 3 trials showed that the grain-fed lambs, before weaning, required 4 lbs. of grain for each 1 lb. of gain made by them, compared with lambs not fed grain. The feeding of grain, after weaning, to lambs not fed grain previously, produced an average increase which slightly more than paid a good market price for the grain consumed, up to the time of slaughter in autumn. No appreciable difference was noted in the gain made, during winter fattening, between the lambs that had grain previous to fattening, and those that had no grain. However, the grain-fed lambs brought 75 cents per 100 lbs. more at selling time than those not fed grain before winter fattening. The grain-fed lambs matured earlier, and grain-feeding made the fleeces more compact and smoother than of those not so fed. The grain-fed lambs sheared an average of 2.2 lbs. more wool than those not fed grain. There was no difference in the character of the meat of the grain-fed and otherwise-fed lambs, and all showed about the same dressing percentage.

Destructive Effects of Wind on Sandy Soils

Prof. King made observations of the destructive effects of winds on the light sandy or sandy-loam soils of the potato belt districts of Wisconsin, in 1894, and reported the results in Bulletin No. 42, of October, 1894. In it he also made suggestions for the prevention of serious drifting. He emphasized the importance of farm-yard manure, green manuring, and frequent rotations for sandy soils. The planting of windbreaks was advocated. Experiments were also conducted to determine the influence of woods, grass fields and hedge-rows on the rate of evaporation, and the amount of moisture in the air over fields to their leeward. The best stand of grain, grass and clover was invariably found to the leeward of such shelters.

Farming Possibilities of Northern Wisconsin Investigated

It had become a matter of common knowledge that Wisconsin embraces one of the best agricultural regions in all America, but the agricultural possibilities of cut-over land, in the northern part of the state, were still to be determined. Development there following felling the great pine forests was yet in the earliest stages. Some held that northern Wisconsin was without an agricultural future, and that any efforts to farm there would prove disastrous.

In 1894, urgent calls came from certain citizens of Superior, to the experiment station, asking that the country tributory to their city might be examined and reported on by the station experts. Heeding their request, Director Henry delegated Professors King, agricultural physics, Goff, horticulture, and Craig, animal husbandry, to make the desired investigation. The party reached Superior July 31, and were rendered every possible assistance. The resultsof the study made by the party, working together and separately, were given in Bulletin No. 43, issued January, 1895. Their reports embodied a number of recommendations and suggestions concerning the clearing of land, the handling of the soil, suitable crops, the kinds of animals to be reared, and general advice which they thought might be of assistance to the settlers. The investigation proved of real value to those interested and to prospective settlers.

Pasteurization of Milk and Cream

In view of the fact that milk is a perishable article, inevitably suffering a change in its physical and chemical composition that soon renders it unfit for human food, and that even with the best of care much loss is caused by the presence and action of entering bacteria, Dr. Russell, in Bulletin No. 44, of April,1895, offered a highly interesting and instructive essay on the pasteurization of milk and cream for direct consumption. That process, together with sterilization, which was not discussed in the paper, was recommended as an effective method of making milk and cream safe for use. He emphasized the fact that pasteurization may well be considered worth while, considering the prevalence of bovine tuberculosis and the possibility of infection of man by the use of the raw milk of affected cows. The various epidemics of typhoid andscarlet fever, as well as diphtheria, being traceable in many instances to infected milk, also made the supply of purer and more wholesome milk imperative. Dr. Russell stated that, so far as was known at the time, pasteurized material is adapted to any use for which normal milk and cream are suitable, and that when treated in the way detailed in his bulletin on the subject, the destruction of germ life in the milk averages about 99.7 per cent. The effect of the treatment, by stopping the putrefactive and fermentative processes of so much organic life, cannot fail to be attended by other than beneficial results.

The minimum limit for pasteurizing milk should, wrote Dr. Russell, be a point at which the tubercle bacillus is killed. The maximum temperature that can be employed is determined by that degree of heat which is sufficient to give the milk a permanently cooked or scalded taste. These limits vary in connection with length of exposure, but, in general, an application of heat for 20 minutes at 155 degrees F. has been chosen as a medium standard. To gain the best effect in pasteurizing, the heated milk should be chilled quickly and thoroughly as possible, so as to prevent the germination of those bacteria, in a spore condition, that have been unaffected by the heating process.

Dipping Sheep

In the twelfth annual report of the station, Prof. Craig contributed an illustrated article regarding a dipping vat for sheep, and gave details for its construction and use. It was advised to dip sheep as early as possible, to free them of ticks and lice, and to repeat the dipping in autumn, if needed. After dipping 119 sheep of the station flock, a considerable quantity of fluid remained in the vat, and this was used to dip the swine which had become infested with lice. Over 50 hogs were run through the dip fluid in less than an hour. The dipping was found effective, and lessened the labor entailed by washing the hogs or sprinkling them with any fluid for killing lice.

Further Data for Dairymen

The chemists and bacteriologists of the station, in 1894-5, continued their excellent work of furnishing the creamery men and cheese makers of the state with scientific and practical information for the improvement of their manufacturing methods and products.

Dr. Babcock first dealt with the character of casein. Previous experiments had indicated that casein is in suspension rather than solution; therefore tests were made to determine whether casein, in its natural condition. could be separated from the milk by centrifugal force. Separator skim milk was employed. After whirling for a time, the bowl was found to be covered with a rather firm jelly-like deposit, about one-eighth of an inch thick. Chemical tests showed the deposit to consist, in large part at least, of casein. Analysis showed, too, that a considerable portion of both protein and ash had been separated from the milk by the centrifugal force, portions of these constituents being suspended in an insoluble form in the milk. Further tests showed that casein is more easily separated from the milk than the insoluble phosphates of the ash. The sugar, albumen, and a large portion of the ash, were evidently in solution, as their amount in the milk was not diminished by whirling. Another test led Dr. Babcock to conclude that the insoluble lime salts of milk are to some extent increased by heat, and that the larger amount of ash found in the residue from pasteurized milk is due to this rather than to development of lactic acid in fresh milk.

Experiments made at the station showed that practically 9 per cent of the fat of milk is lost in making cheddar cheese. The loss is less when the whey is separated without breaking the curd. Tables were printed in the twelfth annual report showing the average composition and relative cheese producing capacity of milk from 55 patrons of the university creamery, and others showing the yield of cheese from 100 lbs. of milk, and the relative cheese value of milk, corresponding to the per cent of fat and readings of the Querenne lactometer at 60 degrees F.

Dr. Russell reported on the effect of aeration on the flavor of tainted curds in cheese making. It was observed that curd in an aerated vat had a finer flavor than had that in the control. No difference was noted in the number of "pin holes" in aerated as compared with the non-aerated curd.

Russell and Decker also noted the influence of acid on the texture of cheese. They made cheese, from the same lot of milk, in two different ways. In one, the milk was set without developing any acid; in the other, it was ripened according to the usual methods. The results, from several identical tests, were that the texture of the cheese fresh from the press was invariably more porous in those made up "sweet" than where the usual amount of acid was allowed to develop. The development of lactic acid results in the closing up of the pores in cheese.

Dr. Babcock described the hot iron test. Under certain conditions, curd will adhere to an iron heated nearly to redness, and when pulled away will be drawn into threads. The length of these threads is supposed to be proportional to the acidity of the curd, and is taken as a measure of this. The length of the threads is noted. Long threads are usually associated with high acid. Tests did not prove this to be true. It appeared that the hot iron test indicates not the degree of acidity, but a condition of the curd which may be brought about in a variety of ways. Any reagent, whether acid or alkaline, which has a slight solvent action upon casein, will cause curd to string upon a hot iron. Dr. Babcock concluded from his tests that the determination of acid can never replace thehot iron test in practical cheese making as it often fails to show that condition of curd essential to a fine textured cheese. He also found that when the albumen in whey which is not acted upon by rennet in curdling milk for cheesemaking is distributed in the milk and incorporated with the curd, when rennet is added, the yield of green cheese was increased a little more than 17 per cent. The cheese so made soon acquired a sour, disagreeable taste, and a granular texture similar to that of cottage cheese. A number of tests had the same result. Not a single cheese of good quality was produced, where albumen had been added.

From an experiment, J. W. Decker concluded that, considering the time required to make cheese, and not considering the liability of whey-soaked curds, it makes no difference whether the acid is developed in the milk or in the whey, but that it does require more time, where the whey is drawn before the strings appear in the hot iron test.

Tests by Dr. Russell showed that the organisms which produce gaseous fermentations in milk were widely distributed throughout the section tributory to the university creamery. A larger number of the patrons had "gassy" milk in the winter than during summer. "Pin-holes" were found in the milk of 24 of the 42 patrons who delivered milk from April 3, 1895. In

4 instances, the milk was uniformly free from any trace of gas, and a gaseous condition was found, about one-half of the time, in the milk from the remaining 14 patrons. The test showing the presence of gas producing germs in milk is also valuable for the reasons that it also reveals other peculiarities that have an important bearing on the physical characteristics of the curd, and reveals the presence of bacterial taints other than those caused by the gas producing germs. In several instances, the presence of peculiarly offensive odors was noted in milks that had practically no gas in them.

Gaseous Fermentations in Canned Vegetables

During 1895, a leading cannery operator appealed to the station for a remedy for gas formation which spoils canned vegetables and makes the cans "swell". Dr. Russell tackled the problem, and discovered two different species of bacteria in the cans. One of them was capable of fermenting sugar solutions and causing a copious evolution of gas. Cooking the cans experimentally under a steam pressure of 18 pounds, at a temperature of over 250 degrees F., ended the trouble. Dr. Russell concluded that for cannery operation "a repetition of former disastrous losses could be almost entirely prevented by the application of increased pressure, without necessarily lengthening the time of exposure."

Work of Profs. King and Goff

In 1895, Prof. King made some preliminary experiments on the prevention of night frosts, by means of torches, smudges, etc, and the influence of north and south slopes on the temperature of the trunks of fruit trees Continuing his tests relative to the necessary loss of dry matter in corn silage, Prof. King decided that such loss is considerably less than 10 per cent and is probably as low as 5 to 8 per cent. Well built silos, and a proper handling of silage, can reduce the loss from 10 to 15 per cent, below what has been reported as the average, a saving which would add largely to the profits of a farm where 100 or more tons of silage are put up.

From further experiments in strawberry culture, Prof. Goff concluded that the earlier formed plants are most productive, and that plants cannot be depended upon to form well matted rows late in the season. Irrigation of strawberries was again practised the season in 1895, which was one of the driest in the history of Wisconsin. Twelve rows of Warfield and four rows of Wilson strawberries, well irrigated throughout 1894 and 1895, yielded 561.3 boxes. When irrigated in 1894, but not in 1895, they yielded 111.6 boxes. When never irrigated, they yielded 66.2 boxes. Prof. Goff advised that extensive growers of strawberries would be warranted in providing steam power for irrigation pumping, where water is available near at hand and without high lifting. Irrigation of cabbage and cauliflower did not prove profitable to the extent it did with strawberries, as they are much better drought resisters.

The tobacco curing experiments of 1894 were continued in 1895, and again showed the value of the psychrometer in the curing house and the importance of maintaining a steady temperature and degree of moisture, using stove heat where necessary to accomplish the object.

From 1889, Prof. Goff had been studying conditions affecting the starch content of potatoes, and continued them in 1895. He found that different varieties of the potato, grown under the same cultural conditions, may vary in their food value to the extent of one-half or more. The starch content of the same variety, in the same soil, may vary condiderably in different seasons. Different tubers of the same variety, similarly grown, may vary in starch content one-third or more. The tubers that grow deepest in the soil are richest in starch, as were those grown closely in drills. The higher the starch content, the sooner the potato cooks, and the more it swells in cooking. The flavor of potatoes is not necessarily dependent upon their starch content.

Progress During 1895-1896

By the time the thirteenth annual report for the fiscal year ending June 30, 1896 was to be ready for distribution Director Henry expected that the joint Horticultural Agricultural Physics building would be completed. This structure was to have a frontage of 76 feet, with a depth of 60 feet, and be three stories high with a basement and roomy attic. In the rear were three greenhouses with a total width of 80 feet, and a length of 75 feet. The new commodious dwelling for the director was under construction, and a driveway was planned to pass the Dairy building and the new residence connecting Linden Drive and the Lakeshore Drive.

During the past year forty acres of marshland, adjoining the university farm on the northwest, had been secured for future use when reclaimed. The station domain had also been increased by occupancy of all of the ~~pasture~~ tract, known as Camp Randall, as a fenced in pasture.

During 1895, an attempt had been made by the New York Agricultural Experiment Station to have Prof. Henry and Dr. Russell affiliate themselves with that institution, but they preferred to remain in Wisconsin. A strong effort had also been made to separate the Wisconsin College of Agriculture from the University and establish it elsewhere, as a separate organization. A bill to that effect was introduced in the legislature of 1895, and its passage urged by Hon. H. C. Adams and many farmers. It failed of passage in the Assembly by only a few votes. A similar bill, introduced the following session, received no material support. President Adams and the Board of Regents successfully combated both attempts.

In the spring of 1896, the station began the issuance of newspaper bulletins containing matter of general or special interest to farmers, and they were given wide publicity by the press. From July 1, 1895, to June 30, 1896, 7 regular bulletins, a special bulletin on the Fertilizer Law, and another on Hog Cholera were issued.

R. A. Moore Made Assistant

In 1895, Director Henry appointed Ransom Asa Moore his assistant, and gave him charge of the newly organized Short Course in Agriculture. Later, Prof. Moore was made Agronomist of the Experiment Station and became renowned by his remarkably successful development and dissemination of pure bred seeds. He also organized the Wisconsin Experiment Association He was brought up on a farm near Kewaunee, Wisconsin, and before coming to the station had taught in the rural schools of Kewaunee County, 1882-1888, and had been principal of graded schools, 1888-1895. He was educated in the district and normal schools. In 1903, he was made Professor of Agronomy, and in 1932 was honored by the University of Wisconsin with the degree of Master of Arts, in recognition of his meritorious work and notable achievements.

Apple Culture

Of the seven bulletins published by the station during the fiscal year, Bulletin No. 45, of July, 1895, by Prof. Goff, furnished notes and data from 172 apple orchards in Wisconsin. The matter presented was gleaned from replies sent by apple growers in response to a questionaire mailed to them during the autumn of 1894. The testimony gathered showed that apple culture was in a fairly healthful and growing condition in the southern and eastern parts of the state, and in Waupaca, Richland, Sauk and La Crosse Counties. The bearing trees were probably as productive as in any other state of the Union, and prices received for fruit were generally good. A considerable number of new orchards was being planted, and new varieties were being tested. Spraying was becoming general.

Centrifugal Cream Separators

During 1894 and 1895, tests were made to determine the power required for running the different kinds of centrifugal cream separators in use in the Hiram Smith dairy building. A. W. Richter reported the results ~~of the results~~ of the tests in illustrated Bulletin No. 46, of October 1895. He found that the power required to run the machine varies chiefly with the mechanical construction and speed of the bowl, while the capacity of the machine farther effects the amount of steam required per 1,000 pounds of milk separated. A careful consideration of all points involved, relative to decision of the question whether the belt or the turbine separator is the more economical, showed that whatever difference there may be between the two styles of machines is on the score of convenience rather than economy.

In Bulletin No. 47, of November 1895, Prof. Henry published and commented on the Wisconsin Fertilizer Law which became operative from and after December 1, 1895. He announced that after that date the Experiment Station would receive samples of fertilizers submitted in compliance with the law, the results of analyses to be given in a later bulletin.

Professors Farrington and Russell experimented with the ferment or culture discovered by Prof. H W. Conn, in 1893, and known as "B 41"(Bacillus No. 41) for use in butter-making. That scientist had found the"B. 41" organism better than any of those he had yet discovered in normal milk and cream. Unlike other commercial ferments "B. 41" is not a typical lactic acid bacterium. While it produces acid in a small degree, it acts ~~never~~ more upon the casein constituent of milk, than it does upon the sugar. The results of the tests, which were in progress for 19 weeks, beginning in July, were published in Bulletin No. 48, of January, 1896. The experiments which were numerous, thorough, and technical, were fully explained and discussed in the bulletin. The results were, on the whole, unfavorable to the culture, and failed to confirm, among other things, the claim that the B. 41 "as a cream ripener, retards the development of acidity in the cream".

In Bulletin No. 49, by Prof. Woll, published March 1896, in accordance with the Wisconsin Fertilizer Law of 1895, results of the analyses of fertilizers licensed for sale in the state, were given and a description of fertilizing ingredients furnished, together with information regarding barnyard manure, green manuring and the various types of commercial fertilizers.

Treating Grain Against Smuts

Smut on oats, wheat, and barley was said, by Prof. Goff, in Bulletin No.50, of March 1896, to be costing farmers of Wisconsin, annually, more than the total cost of the state capitol. After describing the offendidg smuts he advised how they might without difficulty or danger to the seed protect it successfully against smut by applying the hot water treatment devised by J. L. Jensen, of Denmark, in 1887. That test consisted in immersing the seed grain in water at a temperature of 130 to 133 degrees Fahrenheit. Oats should be immersed for 10 minutes. Wheat should be soaked in cold water for 4 hours, allowed to stand for 4 hours, and then be immersed for 5 minutes in water at 132 degrees Fahrenheit, to kill loose smut. The treatment prescribed for wheat also prevents loose and stinking smut in barley. Over hot water may injure the grain.

Wisconsin Marls

Calcareous or shell marls being found in a large number of places in the state, especially in the central and eastern counties, Prof. Woll, in the autumn of 1895, asked farmers to send samples for analyses. The marl beds, especially in Waupaca County, were easy of access for inexpensive digging. The analyses of 44 samples of marl found in the state were printed in Bulletin, No. 51 of June 1896, and instructively discussed. Twenty-eight samples of shell marl, out of 38 examined, contained above 85 per cent of pure carbonate of lime. Phosphoric acid and potash were absent in all of the samples. Other samples that contained some phosphorus and potash were clay marls and deficient in lime. They were scarce. Where available in large quantities, marl was recommended as valuable for composting with farmyard manure, peat, sod, weeds and other waste materials.

The uses of marl were explained. The annual report for 1895-6 also contained several other papers of interest and instruction to farmers.

Director Henry gave an account of tests he had made comparing corn with corn meal as a feed for hogs. He found that with heavy hogs in ~~their flush~~ thin flesh at the beginning of the trial, 8 per cent of corn was saved by grinding. With light hogs, rather fat at the beginning of the trial, 17.6 per cent of corn was saved by grinding. He concluded that where hogs are in condition to make the best use of corn, there is little need of grinding it, unless the kernels are unusually hard and dry; but it may pay to grind corn for pigs that are fattening well, or that are not entirely vigorous and strong. He also conducted experiments in seeding grass lands without a nurse crop, and concluded that there is absolutely no necessity, under ordinary conditions, for sowing oats, barley, or any other grain with grasses for the purpose of yielding shade and protection. Grasses and clover sown by themselves on properly prepared soil, spring up at once and make rapid growth, bearing seed heads the same year; and if all conditions are favorable, produce an excellent crop the same season. Weeds are the most serious objection to the seeding of grasses by themselves. He advised the sowing of two or three times the usual amount of seed very early in the spring. When weeds reach a height of six inches, they should be mowed with the cutter-bar set about four inches high. Sometimes this may have to be repeated. Drs. Babcock and Russell discovered by various tests, that the consistency or body of milk and cream is due to the viscosity of the serum imparted by solids in solution, and by the mechanical state of suspended fat and other substances. In milk, the casein exerts a greater influence than fat on consistency, while in cream this fat has the greater influence on account of its high percentage. The aggregations of fat globules also have a very important influence in determining the consistency of milk, and especially cream.

Bacteria in Cheese

Tests made by Dr. Russell relative to the rise and fall of bacteria in Cheddar cheese during the curing process showed that there is first a marked falling off in the number of bacteria in green curds for a day or so, which is followed by a very rapid increase in their numbers. This period is then followed by a diminution in their numbers, until the germ content sinks to insignificant proportions. The bacterial flora of cheese differs markedly from that of milk in which the lactic acid bacteria predominate. Along with them are always bacteria capable of developing gaseous by-products. In the ripening process casein digesting bacteria are quickly eliminated, while the gas-producing bacteria disappear more slowly; the lactic bacteria, on the contrary, develop enormously until the cheese is partially ripened when they too begin to lessen in numbers. He consideded it improbable that digesting bacteria are able to break down the casein, in cheese as they do in milk, because this type of bacteria fails to increase in the cheese and usually disappears before evidences of physical changes in the condition of the casein appear. This is also true where cheese is made from pasteurized milk, to which starters containing digesting bacteria have freely been added.

Where lactic acid bacteria have been destroyed by pasteurization, cheese fails to ripen normally, while the addition of a pure lactic acid ferment permits occurence of the normal changes. Dr. Russell, in a following paper, suggested the use of pure lactic acid ferments, in place of home made starters in cheese making. By their use greater uniformity can be secured, without the danger of undesirable bacteria which sometimes enter the home made starters. The lactic acid ferment does not form gas or any other objectionable by-product. With sweet milk, the lactic acid ferment saves three to five hours in the process of manufacturing cheese, and it helps to develop the proper amount of acid for making a typical Cheddar cheese from tainted milks in which the acid develops imperfectly. It also improves the flavor, texture, and quality of the cheese.

The Tuberculin Test

Dr. Russell reported that since the introduction of the tuberculin test, in 1892, many dairymen had used it as a means of of detecting tuberculosis in their herds and that the verdict was almost unamimously in its favor. He gave some interesting data based upon the tests made, and announced that all calves of tuberculous parentage, isolated soon after birth and fed on pasteurized milk, showed no reaction when tested with tuberculin. He also gave an account of 162 tuberculin tests, made in 1896 under the auspices of the station. Twenty-two out of ninety-six full grown animals were found tuberculous.

Subsoiling and Soil Moisture

On October 22, 1895, Prof. King began an experiment to determine the influence of subsoiling on soil moisture. The soil was loosened to a depth of 18 inches. He found that the surface foot of soil contained 1.94 pounds more water than did that subsoiled, while the other three feet of the subsoiled ground contained .34 of a pound more water than that not so treated. By May 5, little difference could be noted in the amount and distribution of water in the subsoiled and non subsoiled ground. Subsoiled ground, where evaporation was prevented not only retained the 254 pounds of water given it, but acquired 14 pounds additional through upward and lateral capillarity during the four days of the test. Subsoiling profoundly influenced the capillary movement of soil water, and increased the percolation or gravity capacity of the soil stirred for water. Subsoiling, to be most effective, should be so done that the soil is left loose. It should be done when the subsoil is dry, in the fall after the cropping has withdrawn the moisture. Subsoiled then, the soil does not lose its open texture before it is reached by the rains to be stored. Prof. King also reported the results of a series of trials made to determine the draft of self-binding corn harvesters.

Horticultural Notes

Having sufficiently tested several varieties of fruits at the station, Prof. Goff, in 1895-6 felt justified in commenting briefly upon them in the thirteenth annual report. The apples reported upon were Hoadley, Orel (Russian), Gideon, Palmer, Baraboo, Okabena, and Forest, and the Martha and Virginia crab apples. Plums, grapes, black raspberries, the improved dwarf Rocky Mountain Cherry, and the ~~Feume~~ Foumi shrub were also tested. The fruit of the latter shrub was found too astringent to be palatable, in the variety tested.

Experiments in sub-watering greenhouse plants were conducted by Prof Goff and his assistant Fred Cranefield. A difference of 27.2 per cent in favor of a bed of sub-watered plants was noted. Compared with the weight of surface-watered plants sub-watered lettuce made the better crop. Few mealy bugs were on the plants in the sub-watered beds, while those on the ordinary bed were badly infested. Cranefield also tested the effect of sub-irrigation for foliage beds by a system of underground tiles and obtained satisfactory results.

Horticultural Physics Building Completed (1890-97)

In the fourteenth annual report for the period from July 1,1896, to June 30,1897, Director Henry announced that the left wing of the horticultural building, designed to accomodate the department of agricultural physics, together with a large plant adjoining, had been completed and equipped at an expense of a little over $20,000. During the summer, plans were in progress for the construction of the proposed dairy barn. Prof. King and Superintendent Adams visited eastern agricultural colleges and many noted dairy farms to study barn architecture and conveniences. Mr. J. T W. Jennings, of Chicago, was employed as the architect and a plan drawn and approved.

The farm lands of the Experiment Station being too limited in area, the "Hill Farm" of 160 acres, located two miles west of the established farm buildings on Sauk Road, was purchased for $13,000.

Prof. John A. Craig, in charge of Animal Husbandry, resigned to engage in private business. Under his able management the livestock interests at the station had materially enlarged and advanced. His research and teaching work had also been eminently satisfactory and inspiring.

Harry Alexis Harding, a native of Wisconsin, and graduate of the University of Wisconsin, was appointed research fellow in bacteriology to assist Dr. Russell in cheese investigations. Later, he held the position of bacteriologist of New York Agricultural Experiment Station, Geneva (1899-1913) and in 1913 was made professor of dairy bacteriology in the University of Illinois, at Urbana. In 1910, he obtained his Doctors' Degree from Cornell University.

The work in agricultural physics having become extensive and laborious, Joseph A. Jeffery was appointed assistant professor, to aid Prof. King. He came from the North Dakota Agricultural College where he had been assistant professor of agriculture from 1896 to 1897, after graduating at the University of Wisconsin. He remained at the Wisconsin Station until 1899; then he was assistant professor of agriculture in Michigan Agricultural College from 1899 until 1902; professor of soils and soils physics 1902-1913; and soils physicist of the Experiment Station, 1908-1913. On leaving Michigan he became Land Commissioner to the Duluth, South Shore and Atlantic Railway at Marquette, Michigan.

Alfred Vivian, a native of Wisconsin, and graduate of the department of Pharmacy of the University of Wisconsin, was made assistant chemist of the Experiment Station, in 1897 after having served for two years as student and helper. He served until 1902, when he was appointed associate professor of chemistry in Ohio State University. He was made professor in 1905, and Dean of the Ohio College of Agriculture in 1915. He became well known as a lecturer, and his books on the first principles of soil fertility and everyday chemistry were well received.

In 1896, Miss Ida Herfurth, of Madison, was engaged as chief clerk and stenographer of the Experiment Station.

Summaries of the bulletins issued from July 1, 1896 to June 30, 1897, follow:

The Babcock Test and Gravimetric Test Compared

Prof. Farrington tested samples of skim milk by Dr. Babcock's method and also by the gravimetric method of estimating fat. He presented drawings in Bulletin No. 52 of July 1896, to show, as nearly as possible just what per cent is represented by the few globules of fat in the neck of the milk test bottle, when the skim milk tested contains a minimum amount of butter fat. Duplicate gravimetric analyses, of the same samples, gave 0.15 per cent and 0.135 per cent fat, a variation no greater than chemists usually find in two analyses of the same sample. Accurate testing of skim milk by the Babcock method required attention to the following details: Clean bottles; about one-third more than the usual quantity of acid; sufficient speed of the testing machine; running the tester at full speed for at least five minutes; and close attention to the thickness of the fat globules, as well as their surface measure. Special bottles were devised and illustrated for testing samples of butter milk or skim milk containing very small amounts of fat.

Prof. Farrington, who had first described the alkaline tablet test of acidity in milk or cream, in Bulletin No. 32, of the Illinois Experiment Station, explained in Wisconsin Bulletin No. 52, a number of changes which had been made in the way of using it, as practiced in the University of Wisconsin Creamery and Dairy School. The possibility of detecting "preservaline" in milk by means of alkaline tablets was also mentioned and the method explained.

The analyses of fertilizers was continued by Prof. Woll, the results being tabulated in Bulletin No. 53, of July,1896, and a special bulletin, not numbered, of November,1896, gave the text of the State Fertilizer Law.

Restoring Consistency of Pasteurized Cream

Pasteurization of cream having now been widely practised, an objection to the process arose on the basis that it reduced the consistency of the treated product. So serious had this objection become, on the part of the consumer, that it militated strongly against the further introduction of the method. Profs. Babcock and Russell, therefore, sought a remedy for the ill effect, and in Bulletin No.54, of August, 1896, stated that they believed they had finally accomplished the desired end. They, therefore, gave a preliminary report of the purely practical results of their experimental work, reserving the more scientific discussion of the subject for the forthcoming annual report. The necessary apparatus for the restorative operation was illustrated and described.

Use of Viscogen

They discovered that the consistency of pasteurized cream may be restored by the addition of lime in solution. For the purpose they used lime dissolved in a solution of cane sugar (sucrate of lime), as ordinary limewater was unsuitable. This solution of lime in sugar they named "Viscogen", on account of its viscous producing powers, and the treated products they called, visco-cream, visco-milk, etc. Instructions for making and using viscogen were given and the statement made that it may be employed for the following purposes: to restore the consistency of pasteurized cream; to increase the body of separator cream; to increase the viscosity of cream designed for whipping; and to give body to condensed milk, where that proves practical.

Beet Sugar Production

Great interest having arisen relative to the growing of sugar beets and the production of sugar from the roots, as indicated by numerous letters of inquiry received at the Experiment Station, Prof. Henry in profusely illustrated Bulletin No. 55, of December 1896, gave full information on the subject. He stated in his recommendations, that the sugar beet succeeds best where the summer temperature averages 70 degrees, Fahrenheit, and that the whole of Wisconsin may be considered as the sugar belt. The writer believed it reasonable to place the minimum yield of sugar beets for Wisconsin at ten tons per acre, which, with better culture, might run to 15 or 18 tons, and in rare instances to 30 tons per acre. Data gathered by the station showed that the soil and climate of Wisconsin form a combination which insured large yields of good sugar beets.

Wisconsin Separator Creameries

In Bulletin No.56 of March 1897, Prof. Farrington published the results of an investigation of the conditions and management of the separator creameries of the state, at that time. Statistics from 52 creamers were compiled, from answers to questions asked the operators, and some of the creameries in 14 counties had also been visited. A similarity in the outfit and operation of all of the creameries was noted. The average separator creamery received, from 40 patrons, about 5,000 pounds of milk per day; the average test of the milk being 3.73 per cent fat. About one-third of the creameries were co-operative. The average distance of the farthest patron from the creamery was four and one-half miles. Nearly all of the creameries used steam turbine Babcock milk testers.

Analyses of licensed commercial fertilizers were tabulated and commented upon by Prof. Woll in Bulletin No.57, of March 1897.

For five years rape had, in various ways, been experimented with on the station farm, for soiling purposes and for fattening sheep and swine. Prof. Craig gave the results in illustrated Bulletin No.58, of April 1897. For these purposes the crop proved very valuable. The plants cannot be cured or stored in any way, but under Wisconsin conditions it remains fresh for pasturing for several weeks. Dwarf Essex Fodder Rape was the variety grown. It does not produce seed the first year. Varieties that do so are useless for fodder purposes. It grows best in humus-rich soils. One acre will serve 20 fattening lambs for two months, when they are also fed one pound of grain per head daily. Swine also thrive well on rape pasture. In one trial, ten hogs on rape ate in 76 days 1.386 pounds of corn, 690 pounds of ~~shoots~~ shorts,

.32 of an acre of rape and gained 853 pounds. Another lot, penned, ate 2,096 pounds of corn, 1,043 pounds of ~~shoots~~ shorts, and gained 857 pounds. The gain being practically the same, it might be said that the .32 of an acre of rape saved 1,062 pounds of grain, or that an acre would be worth 3,318 pounds of grain. Other trials indicated that an acre of rape is worth 2,767 pounds of grain, such as is usually fed to fattening hogs.

To encourage the wider use of silos, Prof. King gave, in illustrated Bulletin No. 59 of May 1897, additional information on their construction of silos and the making and handling of silage. He advised that corn well matured and in good condition for shocking, but with leaves still green, is the proper stage for the silo and clover in full ~~bolim~~ bloom or a trifle past, and in good condition for hay, but not too dry, is best suited for placing in the silo. Valuable tables were presented giving the approximate capacity of cylindrical silos for well matured silage, in tons, and the inside diameter of silos appropriate for herds of cows of different numbers.

Wisconsin's Cheese Industry

Believing that the Experiment Station could be the means of helping many cheese makers of the state to a better understanding of the principles upon which their vocation is founded, a series of popular bulletins on the subject was outlined in 1896-1897. The first of these, Bulletin No.60, written by Dr. Babcock and Dr. Russell, appeared in May 1897 and presented a colored map showing the distribution of cheese factories and creameries of the state, an account of the historical development of the cheese industry in Wisconsin, and a statement of the advantages of the state for cheese production. The writers concluded that by nature Wisconsin seems predestined to be the great cheese state of the future. Her commercial advantages, by reason of her geographical position, her transportation facilities, and the legal restrictions thrown about the manufacture and sale of spurious products, give her a prestige that cannot fail to keep her in the front rank, if she maintains and improves the quality of her product. The state already owed much of its prosperity to the development of the dairy industry. Cheese makers were advised to study their business more thoroughly, and thereby acquire a more complete insight into the <u>why</u> and the <u>wherefore</u> of many of the processes that go on in cheese making. The purposed bulletins were to help them in these studies.

On May 1, 1897, a special unnumbered bulletin, giving information concerning sugar beet culture, was sent out by the Experiment Station. To each of the recipients, by request of his member of the Legislature, a ¼ pound package of imported sugar beet seed was forwarded for trial. It was hoped, however, that the recipient would not be content with the small sample but would plant from one-half to two acres of beets. Directions for growing beets followed.

Swine Problems Studied

In the autumn of 1896 the swine Barn at the station farm was remodeled and enlarged, affording increased facilities for conducting experiments under direction of Prof. Henry. The work was placed in charge of William Watson, a certificate short course student who had shown special skill in such hog feeding.

Facts concerning sows and pigs at farrowing were obtained during the spring of 1897. The sows used were purebred Poland Chinas and Berkshires, or crosses of those breeds or cross-bred Poland-China Chester-Whites. Their litters were found to weigh an average of 16.7 pounds each, the individual pigs ranging in weight from 1.3 to 3.1 pounds; the average being 2.2 pounds. The last pig farrowed in each litter was not necessarily of lighter weight than the others, although a 'teatman' or 'runt' pig commonly is farrowed. Another test showed that the average milk yield of four sows ranged from 4.1 pounds as the minimum, to 5.8 pounds as the maximum, daily for the three days under observation. Nine samples of sows' milk analyzed showed an average composition of 80.35 per cent water; 8.24 per cent fat; and 11.41 per cent of solids not fat. Milk sugar averaged 4.75 per cent. The average fat content of 68 samples of sows' milk, as shown by tables published is 6.74 per cent. The fat globules of sows' milk were found to be very small. The gain made by the sow and her pigs before weaning was 20 per cent more economical than gains made by the same pigs after weaning. Prof. Henry therfore advised that the stockman "can well afford to crowd his brood sows with feed, giving the young pigs all they will take from a side trough before they are weaned, so long as the feed thus given works no injury to the animals."

Cheese Ripening

Doctors Babcock and Russell, in the fourteenth annual report, gave an account of the work they had been doing relative to the changes which cheese undergoes during curing, with the final purpose to perfect a rational system in the manufacture and curing of cheese. They gave it as their belief, to date, that the ripening of hard cheese, instead of being due solely to bacteria, is caused by the joint action of both organized (bacteria) and unorganized ferments (enzymes). The breaking down of the casein they considered undoubtedly due, in larger part, to the action of enzymes. Concerning the production of the characteristic flavors in cheese, their knowledge was, as yet, too vague to warrant a definite assertion as to their origin; but they deemed it probable that the bacteria, in this relation, play a much more important role. Low temperatures were advised for the curing room. In Wisconsin, the ordinary curing room almost invariably reaches a temperature, in summer, incompatible with proper curing. Under cold storage conditions cheese can also be held in safety, to sell at opportune times.

Soil Moisture Experiments

Prof. King, during 1896-7 continued the study of soil water problems which had engaged his attention for three years. He experimented to determine the influence of varying amounts of water on the yield of barley, clover, potatoes, and corn, and on the influence of the number of plants on the yield per acre. Irrigation benefitted the barley, rainfall having been light, and greatly improved the stand of clover. He concluded that with plenty of water, either as rain or irrigation, both the first and second crops of hay may easily be made double what is usually realized, and that plenty of water, at the right time, is indispensable to the largest yield of potatoes and corn. Irrigated potatoes were much less injured by "tip-burn", than those not irrigated. The largest amount of shelled corn was associated with the thinnest seeding, which also required the least additional water.

The work by the physicist, on the treatment of swamp or humus soil, was continued, partly in the field and partly in the plant house As one result of his work, Prof. King thought it clear, in regard to the treatment of black marsh soils, that they respond well to farm-yard manure and even to coarse litter of any kind, when well worked in, while the commercial chemical fertilizers tried, other than potash, have but little influence. Pot culture tests of the productiveness of the soils of the pine barrens of Douglas County, Wis., were also made and it was determined that, with irrigation and judicious fertilization, good crops may be produced upon them.

Prof. Woll, in the fourteenth annual report again published the results of analyses of licensed fertilizers, with advice relative to the nature of their constituents, and their use on crops. He also gave a further account of fertilizer experiments with corn on marsh soils reported by Prof. King. An experiment conducted by Prof. Goff during the seasons of 1896 and 1897, indicated that there is some foundation for the belief that an earlyblooming pollenizer tends to hasten the maturity of a later, pistillate strawberry planted with it.

Prof. Goff continued the work begun by Prof. King relative to the root growth of certain perennial plants. He also studied the influence of varying amounts of water on the germination of beet seed. Excessive moisture was found detrimental, and it appeared, from the results obtained by use of seed testers, that the germination of beet seed in the open ground is liable to be presented by excessive water in the soil. Notes were also published relating to a comparison of a dwarf variety of tomato, developed by Prof. Goff at the station, with three standard varieties. The "station" tomato gave a smaller percentage of seed than any of the other varieties, and produced fruit of rather small size. Some private gardeners had come to esteem the variety, but as yet it had not become popular with market growers, though superior in earliness, productiveness, and freedom from decay of the fruit. The degree of cold endurable by flower buds of the plum and cherry was also noted, and the conclusion arrived at that those of the cultivated plums that are native to this country are capable of enduring, without harm, a greater degree of cold than those of the European or Japanese plums, and that of the native species, those of *Prunus Americana* are hardiest. Of cherries, the Dye House, the Large Morello and Late Morello of the European varieties suffered least from cold; while the flower buds of the native *Prunus subcordata*, *P. maritima* and dwarf Rock Mountain Cherry, *P. Besseyi*, appeared wholly uninjured.

The Station in 1897-1898

In the fifteenth annual report of the Experiment Station, for the fiscal year ending June 30, 1898, Director Henry reported that the discovery of unorganized ferments in normal milk, as announced by Doctors Babcock and Russell in the fourteenth report, had excited keen interest among dairy scientests everywhere. The investigators were continuing their studies in the same line, and it was believed that much practical good, in the end, would come from their efforts. The investigations in the making and curing of cheese at the Station had now reached a point requiring more ample and elaborate equipment for advanced studies. It was hoped, therefore, that the legislature at its next session would make provisions for bringing the dairy building up to the new requirements. During the past year a barn for dairy cattle had been completed on the university farm at a cost of about $16,000, with $2,000 additional for equipment. A central heating plant was to be asked for as the next necessity in the building equipment of the station.

During the spring of 1897, about 4,000 pounds of sugar beet seed were distributed among the farmers of the state, and in the autumn, through the generosity of the railroad companies, nearly 2,000 sample packages of beets were sent by the growers to the station for analysis. Active work had been going on for the furtherance of beet sugar production in Wisconsin; but owing to the acquisition of the Sandwich Islands, and results of the war with Spain, Director Henry deemed it probable that the sugar consumed in the United States would once more be produced in tropical countries from the ribbon cane. It seemed likely, therefore, that the station would discontinue sugar beet investigations as no longer necessary.

The Station Staff Augmented

H. A. Harding, assistant to Dr. Russell in his investigations in dairy bacteriology, having been appointed to the chair of bacteriology in the New York Experiment Station, Geneva, H. V. Bassett, a graduate of the University of Wisconsin was appointed assistant in bacteriology.

William Levi Carlyle, a native of Canada, was elected by the Regents in the autumn of 1897, to succeed Prof. J. A. Craig, as animal husbandman, that officer having resigned, as announced in the fourteenth annual report. In 1892, Prof. Carlyle had graduated with the degree of Bachelor in Agriculture, from Toronto University College of Agriculture He had then taken graduate work at the Provincial Dairy School, Guelph, Ontario, in 1893, and in that year was in charge of the Provincial Traveling Dairy School, after lecturing on animal husbandry and dairying at the Ontario farmers' institutes. From 1894 to 1897, he was lecturer on dairy farming and dairy science, and traveling instructor in cheese factories and creameries, for the Minnesota State Farmers' Institutes. He became a most popular teacher at the Wisconsin College of Agriculture and quickly gained the confidence and esteem of the stockbreeders of the state, as a judge and wise counsellor. From 1903 to 1905, he was professor of agriculture in Colorado Agricultural College; then dean of that institution, from 1905 to 1909. From 1910 to 1915 he was Dean and Director of the Idaho Agricultural College and Experiment Station, and from 1915 to 1918, he held the same position at the Oklahoma Agricultural College. He then became agent for the Prince of Wales and manager of his "E.P." ranch in Alberta, Canada.

During the year ending June 30, 1898, the Station published eight bulletins relative to the subjects reviewed in the following paragraphs:

Constitution of Milk for Cheese Making

The second of the series of bulletins promised by the Experiment Station for the aid of cheesemakers in improving their methods and products, appeared in September, 1897, as Bulletin No.61. It was writt by Dr. Babcock and discussed the constitution of milk with special reference to cheese production. It dealt with the nature and secretion of milk: its yield: physical constitution: fat globules: chemical constitution: enzymes: variations: conditions affecting composition: relative values: relation of milk constitutions to cheese: Calculation of the yield of cheese with tables showing yields from 100 pounds of milk, corresponding to per cent of fat, and readings of the Querenne Lactometer at 60 degrees F.

Dr. Babcock, in conclusion, remarked that the reputation of Wisconsin cheese could be restored to its former position, only, by the production of a product of the highest grade. The natural and educational advantages of the state would make that possible. The crying need, at the time, was for a better milk in the cheese factories, and this could easily and quickly be secured, were the milk producers at once assured of just compensation for their efforts in that direction.

Tainted or Defective Milks

Dr. Russell followed, illustrated in Bulletin No. 62 of September 1897, with information for cheese makers relative to the causes of milk tainting and deficiencies and prescribed methods for their prevention. He paid special attention to taints or defects produced by the presence of living micro-organisms and those due to the absorption of pre-existing odors from the air or food, or to the derangement of the normal functions of the cow. He explained, first, how living organisms gain access to milk and the conditions that favor their development. Next, he considered the various kinds of infection, such as lactic acid fermentation, gassy milk, sweet curdling and digesting fermentation, slimy fermentation, bitter fermentation, various other fermentations, and disease bacteria in milk. Direct absorption of taints and the sources of taints were next discussed and treatment suggested for milk contaminated with bacteria and for that tainted by direct absorption. Methods of eliminating taints were also given, and the effects and value of pasteurization discussed. The paper concluded with practical advise regarding the hygienic and sanitary care of cows, milking, storage, and transportation, and care of milk utensils.

Culture of Native Plums

Prof. Goff had continued his investigations of native plum culture, and in illustrated Bulletin No.63, of October 1897, filled some 66 pages with interesting and instructive data on the subject. He believed that the adaption of the native plum into culture on a market scale would be a decided step of progress in American pomology, and especially important for the reason that, at least one species of the native plum would be likely to prove our hardiest tree fruit, with the possible exception of some of the crab apples. Instructions were given for the propagation of native plums, together with information and advice relative to suitable soils, distance in planting, arrangement of varieties, pruning, insect and fungus enemies, preventive measuses, methods of spraying, and a list, with descriptions and some illustrations of nearly 200 varieties of plums.

Sugar Beet Seed Distributed

In 1897, the U. S. Department of Agriculture, through the courtesy of Secretary James Wilson gave the Experiment Station half a ton of sugar beet seed for distribution under a franking privelege. Other seed was bought by the station from the Menominee Falls Beet

Sugar Co. or imported directly from Germany or France. The legislature of 1897 passed a bill appropriating $500 for distribution expenses and directed that each member of the Senate and Assembly be allowed 100 seed packets for distribution in his district. The seed was sent out during the latter half of April and the beginning of May, 13,766 packages being distributed, and with each went a copy of the special sugar beet bulletin of the Station, dated May 1, 1897.

Analyses of the beets grown from these samples were published by Prof. Woll, in Bulletin No.64, of January, 1898. The samples had been forwarded to the Station, free of charge, by the railroads of the state. The highest average for sugar in the juice was obtained for Oconto County, with 15.48 per cent, followed by Door County with 15.11 per cent. Forty-nine counties furnished beets averaging above 12 per cent. in sugar, 26 ~~per cent.~~ counties above 13 per cent. and 8 counties above 14 per cent. The Lake Shore region proved best suited for sugar beet production. The average estimated yield of beets per acre, based upon 1,103 reports, was 13.8 tons.

Bacterial Rot of Cabbage

In Kenosha and Racine Counties, where cabbage growing is an impertant business, rot disease appeared in 1890, but was not troublesome until 1893. In 1895 the affected area had increased and, in 1896, the losses were even greater, many growers losing the entire crop. Less severe losses accurred in 1897. The disease had also caused losses in other parts of Wisconsin.

Dr. Russell investigated the disease, and reported the results in Bulletin No.65. of February, 1898. He clearly explained the character of the disease, its cause, how it enters the plant, how it winters, and the influence upon it of climate. Directions for combating the disease were also given. Removal of affected leaves, at intervals during the months of August and September, was prescribed as one feasible and effective method of control.

Analyses of licensed commercial fertilizers were tabulated and commented on by Prof. Woll in Bulletin No. 66, of April 1898.

Chapter IX.

The Wisconsin Curd Test and Other Dairy Research Work

Factory Tests For Milk

The effort to promote the cheese industry of the state, by the publication of instructive literature regarding its various phases, was continued by the Station as widened by Bulletin No.67, of June 1898, in which Dr. Babcock, Dr. Russell and Prof. J. W. Decker gave information regarding factory tests for milk. The subjects discussed and explained included tests relating to the composition of milk, biological tests, tests at the weigh can, special tests for different purposes, the Wisconsin curd test, the improvised curd test, how to make a test, an improved curd test and interpretation of results.

The Wisconsin Curd Test

In 1895 the Wisconsin Curd Test was originated by Babcock, Russell and Decker, and proved a wonderful help to the cheesemakers of the state. It was fully described in Bulletin No. 67. The advantages of this curd test over the earlier fermentation tests were that the curd prepared from individual samples of milk more closely conforms to cheese conditions, thereby permitting a more accurate determination of the value of milk for cheese; the development of gas, and the relative amount of the same, can be more easily traced in the curd than in the milk; the removal of the milk serum, with its abundance of fermentable sugar, renders a more accurate test possible; the detection of odors in milk that has been tainted by direct absorption is rendered possible. The method of making the test was explained in the bulletin. It was advised that the other factory tests mentioned in the bulletin should not be ignored in practice as they often throw light upon the character of the milk.

Tests Relative to Rennet

The effect of varying strengths of rennet extract in curdling milk was reported by John W. Decker. For the past two years numerous experiments on the action of commercial rennet extracts had been made at the station. Monrad's rennet test apparatus was used. How to use it was explained. Hansen's rennet extract was the one reported on in 1897-8. Decker concluded that the usual method of comparing the money values of two brands of rennet extract, in which these values are considered as proportioned to the <u>times</u> required in an ordinary rennet test, is not correct. The relative <u>amounts</u> of the extracts required to coagulate the same quantity of the same milk, at 86 degrees F., should determine their relative money values.

A number of experiments were also conducted, with the Monrad rennet test, to determine the action of rennet in milk which had been more or less diluted with water, as such adulteration is occasionally found in cheese factories. They showed that the addition of water to milk greatly lengthens the time required for coagulation; but the amount of such adulteration in a factory would probably not be enough to make a noticeable difference.

Decker likewise experimented to determine the effect of salt on rennet action. He found that salt in milk or in the extract retards the rennet action. The phenomenon of an increased proportional curdling power of dilute rennet extracts is independent of the salt that may be in the extract.

Tests made by Decker in the handling of sour milk in cheese making, showed that both acid and fat were washed out of the curds in the water used for firming them. Cheese, in which the acid had been washed out by water developed, after two months in the curing room, ragged gas holes, and a flavor similar to that of cheese made up in summer without developing acid before pressing, and afterward kept in a warm curing room. The cheese made from curds that had been stirred in the racks to expel whey without use of water, proved close in texture and of a very good flavor. The advisability of washing curds was therefore to be considered questionable.

Relative to the propagation of a "starter" for ripening cream, Dr. Russell described a suitable apparatus for the purpose. He advised that the starter should be prepared fresh every day, a transfer being made from one can to the other, by means of a steamed dipper. He found that a culture of a vigorous growing organism in milk, for a starter, may be kept in a state of comparative purity for several weeks.

Properties of Galactase

A repetition of former experiments made by Doctors Babcock and Russell, with the assistance of Alfred Vivian, confirmed the discovery they had made of certain inherent enzymes in milk believed at the time to be actively concerned in the ripening of cheese. The new ferment was given the name Galactase, and was deemed by the investigators to be the main cause of the breaking down or peptonization of the casein of the milk in cheese. Tests were also made to determin the distribution of galactase at different periods of lactation, and also the quantity present in individual milks at the same period of lactation. A quantitive estimation of the new enzyme, measured by the amount of soluble proteins formed, showed but little difference during the advanced period of lactation; the milks taken at different periods varying in no regular manner. The amount of soluble proteids, during the colostrum period, appeared to be slightly increased at the beginning. In general, while some variation exists in the amount of nitrogenous elements decomposed, it was found that in milk taken from different cows at the same period of lactation, there is a surprising similarity in the amount of nitrogen converted into soluble ~~from~~ form. The milk of different species of animals varies so materially in its chemical composition and reaction, that it was not found possible to secure uniform conditions under which galactase could act. The presence of the ferment could not correctly be said to vary with the amount of proteids in milk.

Experiments relative to the antiseptic value of chemicals such as ether, chloroform, salicylic acid, boric acid, etc., showed that there is a marked discrepancy in their ability to present bacterial changes in milk and their reputed efficiency as antiseptics. They were far more effective in fluids that do not contain substances like fat. Chloroform, ether, benzol, and ~~tolisol~~ toluol were recommended for use in studying the inherent enzymes. Two or three per cent of chloroform was found to keep milk perfectly for experimental purposes.

Tests made by H. A Harding and William Dietrich, under direction of Dr. Russell, showed that absorbed odors are more intense in warm milk than in cold milk. Judges decided this to be true, in 148 cases out of 171, or 86 per cent of the samples of milk tested. The odor of essential oils, especially peppermint, was most actively absorbed; while that from fresh horse manure was absorbed in less degree.

For two years, Dr. Russell had noted an abnormal fermentation of bread, that caused considerable complaint from consumers. The affected bread had become sticky or slimy. Tests were made to discover the cause of the trouble, and numerous colonies of a well characterized organism were isolated that, upon further study, proved to be the well known potato bacillus(Bacillus mesentericus vulgatus). The yeast used in making the bread was found to be the source of the objectionable bacillus. The organism has great powers of resistance, and the temperature at which bread was baked for an hour and a quarter did not kill it. As a preventive of the trouble, all of which were noticed in hot weather, Dr. Russell suggested that bread should be held at a low temperature after it is baked, so that the spores present in it will not germinate so quickly. Small bakings were also advised.

Windmill Efficiency

Prof. King wished to determine just what a power windmill will accomplish during a year of work. To secure the desired data he purchased for the station a 16-foot geared steel power mill from the Aermotor Co. of Chicago, Ill, and erected it on a steel tower of the Agricultural Physics laboratory. The results of the test were published in illustrated Bulletin No. 68, of June 1898. The work of the mill for the year was done on one or more of four pumps; one a reciprocal pump, another of bucket type, and two of centrifugal type. Most of the work was done with the reciprocal and bucket type pumps, the centrifugal pumps proving unsatisfactory. The work accomplished and the wind movement were automatically recorded, hour by hour, during the whole year, and the results presented in tabular form. Like all of Prof. King's experimental work, the tests were conducted in a highly methodical, thorough and scientific manner. The report of the results and the comments thereon filled some forty bulletin pages. Several measurements of the rate of grinding corn, under different wind velocities, with the windmill mentioned, were also made during the year and the results published in Bulletin No. 68.

During the winter of 1897-98 Prof. Henry conducted a third series of trials with whole corn compared with corn meal for fattening ~~ka~~ swine. The trial lasted 84 days and remarkably good gains were made. During the three year's trial 102 pigs were used. The trials showed that the pigs fed whole shelled corn made an average daily gain of 1.34 pounds, while those fed corn meal made an average daily gain of 1.63 pounds. During all of the trials corn meal effected a saving of 8 per cent. over whole corn, and the meal fed pigs gained about two pounds per week more than the others. Further experiments of like sort were to be made.

Professor Carlyle continued the experiments begun by Prof. Craig in 1895 in the feeding of farm grains to lambs before and after weaning. A ration composed entirely of bran never gave good results when fed to lambs before weaning. It is evidently too bulky and difficult to digest and assimilate. Corn gave the best results, with oats ranking next, and bran in third place, while peas were the most expensive feed. The experiments were to be continued.

Prof. Carlyle also continued Craig's feeding experiments with rape. He compared that green crop with clover for growing pigs. The grazing pigs were also fed twice daily, a liberal quantity of a mixture of two parts of cornmeal and one part of shorts ~~shoots~~ by weight. On account of dry weather, the clover was much withered and dried, which made it less palatable and nutritious. The trial seemed to indicate that the pigs, averaging about six months old, made a more rapid gain on rape than on clover pasture. The pigs on rape were remarkably thrifty all through the experiment and relished the green feed which also regulated their bowels.

Root Growth in Spring

In the latter part of March 1898, Prof. Goff made observations to ascertain what practical bearing the early spring root growth of perennial plants may be expected to have upon the operations of transplanting, and early cultivation. He found that root growth starts before stem growth in many plants, and is most vigorous at the apex of the main roots. In spring, root growth is most active near the surface of the soil, the growth starting where it left off in autumn. The evidence brought out in the investigation did not warrant the conclusion that the finer roots of plants may be wisely ignored in transplanting; indeed, it would be well to handle the plant in a manne that will preserve the finer roots. A potted plant may be shifted, or planted out, with far less check to it than occurs when the roots are removed from the soil in which they are established and the nearer this can be approached when transplanting in the field, the better will be the results.

In the fifteenth annual report Prof. Goff also gave an instructive treatise on the development of the strawberry plant through its different stages and a comparison of these stages with the corresponding ones in other plants, as this <u>Morphology</u> of the strawberry plant had received little scientific attention. One of the practical hints offered was that the removal of the runners, throughout the whole season, does not seem warrantable, as the excessive stooling of the stem so promoted, gives too little room for root development. Liberal top dressing with fine manure or very fertile soil, after the fruiting season, would seem to be the most rational method of fertilizing the strawberry plantation. The practice of mowing the strawberry beds after fruiting was endorsed, and burning the cut-off material deemed the most effectual means of destroying insedt and fungus parasites. The burning should be done away from the strawberry bed. The papes on strawberry morphology was followed by one on methods of improving the efficiency of spraying apparatus. Several devices were described as suitable for practical spraying.

F. Cranefield made several tests, during the year, to determine the comparative influence of warm and cold water on plant growth. He concluded that the growth of ordinary field and garden crops is not affected by the temperature of any water ordinarily available for irrigation purposes. No harm would be likely to result from using for irrigation purposes water from the coldest springs or wells. Even in the green house vegetable and flowering plants may safely be watered with unwarmed spring or well water.

Prof. Carlyle furnished a detailed and illustrated description and plans of the new dairy barn and stock judging building which had been built on the station farm. The frame structure building consists of the barn proper, 86 feet long by 50 feet wide, with two wings each 70 feet long, projecting at right angles from each end of the main building with a well lighted judging room 70 by 40 feet, provided with a tan-bark floor and a tier of seats along one side.

Work Done in 1898-1899

In the sixteenth annual report, for the fiscal year ending June 30, 1899, it was announced that the last legislature had generously appropriated $35,000 for enlargement of the dairy building, and construction of a central heating plant; but the money had not yet been made available. The old horse barn on the Station farm had been improved and equipped . In the basement, quarters had been provided for the feeding of two carloads of steers, the storing of roots, and a steam heating plant installed. On the first floor was a dormitory with accommodations for workmen or students, storage room for carriages and wagons, and a room for washing vehicles. The second floor was equipped as a veterinary hospital with an operating room, demonstration room, and numerous single and box-stalls for horses.

As the sixteenth annual report was published on October 1, 1899, it contained announcements of changes in the station staff made after the close of the fiscal year on June 30, 1899. In August, 1899, J. A. Jeffry, assistant professor of agricultural physics resigned, to assume charge of the department of agricultural physics in the Michigan Agricultural College. In September, Andrew Robinson Whitson, of the University of Chicago was appointed to the vacancy. He had obtained the degree of Bachelor of Science from that institution in 1894, and from that time until he came to Wisconsin, had served as principal of the Beloit, Wisconsin high school. From 1899 to 1901 he was assistant professor in the soils-physics department at the Experiment Station, and in the latter year was made professor in the soils department, of which he still was chief in 1932. In 1907, he was a delegate to the International Agricultural Congress at Vienna. His books on soils, and soil fertility(the latter with Walster) and soils of Wisconsin, 1926, have been accounted authentic and useful in their field. He had taken work in geology under Chamberlain, Salisbury and Van Hise, and during two summers worked with Professors King and Shehler in their study of the movements of ground water. He came to Wisconsin to assist Prof. King in the study of soil problems. In 1902, when Prof. King joined the staff of the U. S. Department of Agricultural, Prof. Whitson was given charge of what was, at that time, called the Department of Agricultural Physics. Investigations made by him for Director Henry, led to the establishment of the permanent sub-experiment stations at Ashland, Marshfield and Spooner. In 1907, he studied in the University of Berlin. In 1909, the legislature, largely through the influence of ex-governor Hoard, established the Wisconsin Soil Survey which, in time, covered nearly the entire state, under the supervision of Prof. Whitson. He was an active agent in founding the American Society of Agronomy, in December, 1907, and a charter member and first president of the American Association of Soil Survey Workers. He helped to train men who have become renowned as soil experts in America, Argentina, Australia, China, Colombia, India, Japan, Mexico and South Africa. His work relative to the phosphorus and lime supply of Wisconsin soils, and conditions affecting their availability, has been especially notable and useful.

Another notable addition to the station staff was Arthur G. Hopkins D. V. M. and B. Ag. Iowa Agricultural College, and V. S. Toronto Veterinary College. He was appointed instructor in veterinary science in April, after having done graduate work at the Ontario Agricultural College, and Mc Killip Veterinary College, Chicago, and practiced his profession for some time in Manitoba. His book "Veterinary Elements" became popular as a text for agricultural students.

In September 1899, J. W. Decker, for several years instructor in cheese making, resigned to take charge of the dairy department of the Ohio State University.

V. H. Bassett, B. S., assistant in bacteriology, resigned, and was succeeded by Edwin George Hastings, a native of Ohio, who had obtained his Bachelor of Science degree from the University of that state in 1898, and his Master's degree from the University of Wisconsin in 1899. From 1899 to 1902 he served as assistant, from 1902 to 1905 as instructor, from 1905 to 1909, as assistant professor, from 1909 to 1913 as associate professor, and in 1913 was made professor of bacteriology which position he still filled in 1932. He is a Fellow of A.A.A. and has been an active and influential member of the State Livestock Sanitary Board. His early work in connection with the eradication of bovine tuberculosis, along with Dr. Russell, was highly important and successful. With Dr. Russell he was the author of three useful textbooks on dairy and agricultural bacteriology.

In 1898-1899, the live stock owned by the Experiment Station comprised: 10 horses, 30 dairy cows, 3 heifers, 3 bulls, 10 steers, 20 calves, 100 swine and 150 sheep. There was also a tuberculous colony of 8 cows on the Hill Farm.

The agricultural library contained over 4,000 bound volumes; and the apparatus available for the station in the divisions of chemistry, bacteriology, agricultural physics, horticulture, and dairying inventoried over $23,000.

In the physics department might be seen an original piece of apparatus for determining the size of soil particles; in the dairy department were the original Babcock Milk Testing Centrifuge, and the apparatus used in operating the Wisconsin Curd Test, both invented at the Wisconsin Station.

During 1898, Director Henry published the first edition of his text book "Feeds and Feeding", a text of 670 pages, which was destined to become generally used by agricultural students and the most popular and profitable publication of its kind.

Seven regular bulletins were published during the fiscal year.

Three single page poster bulletins, printed on light manilla cardboard were also sent out, under the following titles: "Cheese produced from the same quantity of milk containing different amounts of fat"(12,000 copies); "Directions for taking and preserving composite samples of milk in creameries and cheese factories"(5,000 copies); "Directions for operating the Wisconsin Curd Test" (5,000 copies). The regular bulletins are briefly summarized in the following paragraphs:

Pasteurization Applied to Butter Making

Butter having been produced in surplus quantities, American dairymen were considering the advisability of preparing butter especially fitted for shipping to foreign markets. Such butter requiring first-class keeping qualities, pasteurization was suggested as a means to that end. The fact that the British market was being supplied with butter from pasteurized milk and cream was an additional reason for an investigation of the pasteurization subject, and it was ~~maxadd~~ made by Prof. Farrington in 1898. The results were published by him in Bulletin No. 69, of September that year. He explained that pasteurization, as applied to butter making, differs from pasteurization for the preservation of milk for direct consumption, in that it merely attempts to destroy the lactic acid, and such other organisms as are found in the milk, without attempting to kill all the resistant germs it might contain. He advised, therefore, that a much briefer exposure, at 155 degrees F., will destroy the organisms in milk and cream prepared for butter making, than is allowed where the milk is treated for direct consumption. When pasteurization was applied in butter making, he found by a number of bacteriological examinations, that the culture starter always was free from all foreign organisms; that practically sterile skim milk for propagating pure culture starters can easily be obtained in general creamery practice; unpasteurized butter scored 40.69, and pasteurized butter scored 40.63, on a basis of 45 as perfect flavor, but 5 percent more of unpasteurized than pasteurized samples scored 42 points or better; the butter made from unpasteurized milk scored considerably lower on "grain or body" than that from unpasteurized milk; there was a slight difference in favor of the pasteurized goods as to quality; pasteurizing increased the keeping qualities of the butter; a richer butter milk was obtained from the pasteurized than from the unpasteurized churnings in hot weather, but at other seasons there was not much difference; the yield of pasteurized butter was, on the average, a little less than from unpasteurized butter. Prof. Farrington concluded that, according to the demands of the American markets, at that time, the introduction of pasteurization into creameries that already made a good product hardly would be justified.

Cooling Cheese Curing Rooms

In Bulletin No. 70, of January, 1899, Prof. King presented methods for utilizing the lower degree of heat possessed by the subsoil, and the deeper ground water, in maintaining temperatures for cheese curing rooms, within the range of 58 degrees to 68 degrees F. It had not yet been determined that ~~this~~ the range of temperatures is the most desirable one for the purposes of the Wisconsin Cheese industry; but it was conceded that within these limits a better product can be secured than is possible during the summer season, under the usual prevailing temperatures. Drs. Babcock and Russell had shown that high temperatures are very deleterious to the quality of cheese. Prof. King figured that there is available for cooling purposes, ground temperatures of 45 degrees to 52 degrees F., and subsoil temperatures from 48 degrees to 60 degrees F. How nearly a curing room may be held to these temperatures will depend wholly upon the construction and management of the room, and upon the rate at which the air in the room is changed. The bulletin gave instructions for the proper construction of the curing room, for the maintenance of the desired temperature and discussed the various methods by which the air may be cooled in curing rooms placed above ground. Regulation of the moisture in the curing room was also considered.

Sugar Beet Investigations

Investigations of problems connected with the culture of the sugar beet were continued by Prof. Woll in 1898, and the results published in Bulletin No. 71 of February 1899. Analyses of 253 samples of beets grown by 121 farmers in different parts of the state had been made and the results were tabulated. The samples averaged 15.15 per cent. of sugar in juice and 78.3 for purity of juice. The average yield of beets per acre was 12.6 tons. The cost of growing and harvesting an acre of beets was $28.73.

Small Fruits in 1898

Prof. Goff, in illustrated Bulletin No. 72. of April 1899, reported tests of various small fruits made by him in 1898. They led him to conclude that, of strawberries tested, William Belt, Clyde, and Splendid appeared, on the whole, most promising. Of raspberries, London(red) was found most satisfactory, and Columbian was especially recommended for canning. Of blackberries, El Dorado was very promising. Of currants, Raby Castle seemed to possess especial value for jelly. Among gooseberries, Downing was not surpassed for general utility. The Loganberry did not seem likely to become a market fruit.

Profs. Woll and Vivian in Bulletin No. 73 of April 1899, gave the results of the analyses of fertilizers licensed to be sold in Wisconsin during 1898, as required by the laws of 1895, Chapter 87, Section 3. A copy of the law accompanied the text and tables.

A Study of Dairy Salt

An inquiry received from a Wisconsin firm during the spring of 1898, in regard to the value of a well-known brand of salt, in comparison with other brands, led Prof. Woll to make a study of the subject. The work was considered important in that the available data was unsatisfactory, no systematic investigation of salt having been made in America or abroad, while the number of chemical analyses of the various brands was very small. From his tests, he found that the leading brands of dairy salt, in general, contain 98 to over 99 per cent of pure sodium chloride, .5 to 1.5 per cent calcium sulfate, .1 to 15 per cent calcium chloride, a trace to .2 per cent magnesium chloride, none to .3 per cent moisture, and none to below .1 per cent of insoluble impurities. A high content of calcium and magnesium chlorides would be likely to cause dampness and caking in salt, on account of the water absorbing power of these compounds. Diamond Crystal salt graded first in quality, Worcester second, and Genesee third. American dairy salts proved equally pure, and in some instances, purer than brands which rank highest in foreign dairy countries. Foreign dairy salts were found, uniformly, somewhat coarser in grain than American butter salts. No special brand of salt stood first in all respects. Prof. Woll concluded that "There is, in general, a fair choice between several gf our leading dairy salts". His bulletin also gave technical information regarding the use of salt in butter and cheese making.

Testing Cows at the Farm

Prof. Farrington, in Bulletin No. 75 of June 1899, announced that a method for determinging the milk value of each cow in the farm dairy herd was now within the reach of farmers. He advised that each cow should be given a chance to demonstrate her butter-producing capacity, and to have it measured by the same method of weighing and testing her milk that the farmer requires of the factory. Directiöns for making farm tests were given. To demonstrâte the procedure, and to obtain some information regarding the economy of production of the common dairy cows of the region supplying milk to the University dairy, tests of the herds of 6 patrons were made. These men had not previously kept any record of the yield or quality of the milk of their cows. The results obtained furnished much of the informative matter of the bulletin, and this initial work on the subject may be said to have led to the home testing of dairy cows which, in time, was to become general and of inestimable value to the dairy industry of Wisconsin and America. In addition to the regular bulletins much matter of instructional value was published in the sixteenth annual report.

Animal Husbandry Work

Director Henry gave the results of his continued trials of whole corn compared with corn meal for fattening swine. The experiments conducted during 1898-1899 showed two per cent in favor of whole corn, but the gains from grinding corn as a food for hogs were not very large in any of the tests made, and negative results might sometimes be expected by feeders.

Prof. Carlyle, continuing feeding trials with rape for young pigs, compared with clover as a grazing crop, obtained results that reversed the findings of 1897, the conditions of the pasturage being different; however, the experiments to date seemed to indicate that young pigs thrive better when pastured on rape than when pastured on clover, all other conditions being the same with both lots. It was advised that farmers should sow small plots of rape at successive periods about three weeks apart during the spring and early summer months to be used for pasturage for their sows and young pigs. No better pasture could be provided for the purpose.

William Dietrich, in a thesis submitted for the degree of Bachelor of Science in Agriculture, presented the results of investigations he had made to determine the amounts of food required by the growing pig to maintain its weight at the different stages of growth, and also to determine the amounts required for increase in body weight at these stages. The thesis was summarized by Prof. Woll in the sixteenth annual report of the Station. Four pigs of about 50 pounds each were used in the experiment which began July 13, 1898, and ended April 1, 1899. Balanded rations were fed. It was found that the food of support equals.88 per cent of the live weight of the animal, in the form of dry matter in corn meal, middlings and skim milk; as reducing this to the equivalent of ~~skim milk, or~~ middlings, a pig can be maintained on an allowance of middlings equal to 1 per cent of its live weight. Particulars were given relative to the gain made from feed during four periods of feeding, and as to some digestion trials with the same pigs.

Prof. Carlyle compared the feeding value of corn with peas ~~in~~ raising lambs for an early market. In ten weeks after weaning, the corn-fed lambs gained 422 pounds, while those fed peas gained 360 pounds, a difference of 62 pounds in favor of corn. From this and other experiments he concluded that ground corn is a better and more economical feed than ground peas for young lambs; that a ewe can raise twin lambs without a greater loss of weight than when raising a single lamb; that the ewes which lose the most flesh while suckling lambs are not necessarily the best mothers; that wether lambs gain more rapidly than ewe lambs while nursing; and that twin lambs nursing one mother gain as rapidly as when there is but one lamb nursing.

Professors Woll and Carlyle found by tests made to determine the economy of heavy grain-feeding of dairy cows that the cost of production of milk was increased 20 per cent. by feeding 12 pounds of grain feed per head daily, instead of 8 pounds. They concluded that the amount of grain which can be profitably fed to dairy cows depends both on the price received for the products and on the digestive and assimilative capacities of the individual cows. So long as the increase in the cost of the ration does not make the cost of producing a unit of milk and butter greater than the unit will bring, it pays to feed grain heavily, but otherwise it does not.

Prof. Carlyle gave an illustrated description of the station dairy herd cow by cow, and tables showing the productive capacity of each and the amount of feed consumed by each animal. He followed this report with the results of an experiment conducted to determine the effect on dairy cows of changing milkers, which showed that with one exception, the changing of milkers resulted in a direct gain in the amount of milk obtained and total production of butter.

Prof. Carlyle also conducted experiments with a view of protecting cows from flies by stabling in screened barns compared with exposure out of doors. The cows confined in the stable lost more in flesh and at the same time ate more food supplied than did the lot out of doors exposed to the swarms of flies. The loss from fighting flies was largely in the percentage of butter fat rather than in the amount of milk given. The increase in the total amount of butter fat given in the one lot over the other in the experiment was not sufficiently great to pay for the increased trouble and expense entailed in the stabling of the cows during the greater part of every day.

Dairying Tests

C. E. Lee, of the University Creamery, conducted a series of experiments, under direction of Prof. Farrington, to determine the effect of salt on the water in butter. He found that the salted butter contained less water, than the unsalted, and the higher the salt content, the less water the butter will contain. Salted butter leaks brine easily, but unsalted butter does not easily lose or plainly show the water it contains. Butter churned to large granules leaves more water in the finished product than is the case when the churning is stopped when the granules are very small.

Prof. Farrington found by tests that white spots on butter are not an indication of defective salt or bad workmanship, but indicate that the butter has been kept in a cold place and so dry that the water in the brine evaporated leaving the salt in the surface. This incrustation of salt upon butter can be prevented by keeping the butter in a moist atmosphere.

John W. Decker made a number of trials of paraffin as a coating for cheese, that substance having been advertised for the purpose by the Standard Oil Company. When properly applied the paraffin coating perfectly protected cheese against the growth of mold; but with carelessly handled coated cheese the paraffin would break away and allow molds to form.

Decker had also designed a simple pipette for taking composite samples of milk from a pail with flaring sides, as well as one with parallel sides, and described and illustrated it in the 16th annual report. The pipette had been used for the past two years with entire satisfaction.

Professors Babcock, Russell, Vivian and Hastings found it advisable to make a further study of the conditions which affect the action of the inherent milk ferment ("galactase") that digests casein announced in the 14th annual report. They considered whether it might not be possible to discriminate more closely between the ferments by studying their decomposition products. They therefore employed different representatives of the trypsin type of enzymes and other ferments including pepsin and rennin. Pure cultures of different types of bacteria were also used, including those which digest prodeids, those which form acids, and those which form gaseous byproducts from carbohydrates. Their report was illustrated by elaborate graphs. It had previously been shown that galactase was related to the tryptic type of ferment action, when the influence of external factors was considered; but when studied, in the new investigation, in relation to the character of the decomposition products formed in milk, the ferment was found sharply differentiated from that of trypsin. The digestion products more nearly approached those produced by the liquefying or peptonizing bacteria than they did any of the ferments of animal origin. The similarity of products formed in the normal ripening of Cheddar cheese with those produced by galactase, where all other factors are ~~contrasted~~ controlled, showed that the main causal agent in the proteolytic changes that occur in these cheeses is galactase.

Ripening of Cottage Cheese

A series of experiments was conducted by Doctors Babcock and Russell and Alfred Vivian to determine the influence of galactase in the ripening of cottage cheese. It led them to consider that the digestion of casein in cottage cheese is due, not so much to the action of vital ferments in and on the curd masses, as had previously been believed, but to the effect of inherent milk enzymes, of which galactase was undoubtedly the most important. The tests also indicated that the lactic acid group of bacteria have no appreciable effect on digestion. Furthermore, it was found that the casein of milk, when precipitated by acid instead of rennet, undergoes a proteolytic or digestive change, in a manner comparable to that which occurs in normal milk.

Alfred Vivian made a comparison of reagents for milk proteids and a study of the Kjeldahl method for nitrogen determination. He devised a scheme of analysis of milk which proved of great assistance through its ease of manipulation and rapidity of action. By its use it had been possible to make a greater number of comparative analyses of the various nitrogenous decomposition products in milk and cheese, than could have been made by any other scheme of analysis known to assistant chemist Vivian. Relative to the Kjeldahl method it was his opinion that the use of potassium permanganate and potassium sulfide is unnecessary in nitrogen determinations in milk and cheese, and thei use had therefore been abandoned.

Temperatures of Cattle

As the normal temperature of the cow is subject to considerable variation, which has to be taken into account when applying the tuberculin test for the detection of bovine tuberculosis, Dr. Russell and V. H. Bassett studied the subject and reported their conclusions in the 16th annual report. They found that the ingestion of water in large quantities may produce a marked fall in body temperature, which might seriously affect the validity of the test. If, however, the water is given in small quantities, at short intervals, the accuracy of the test is not likely to be affected. The effect of advanced pregnancy, calving and estrum, from the limited data collected, did not cause the temperature to fluctuate materially. The shock of dehorning seemed to cause a rise in temperature. External influences had more effect on the temperature than the action of normal physiological processes.

Examinations made by Bassett showed that in no case were tubercle bacilli demonstrated in the milk from reacting cows that had no evident udder lesions of tuberculosis. They showed that an animal may have the disease for a considerable period of time without its milk showing presence of the bacilli.

Variety Tests of Grains

Prof. Moore tested several varieties of grains to determine their value for Wisconsin farmers. He pronounced Mandscheuri barley especially adapted to our soil and climate. Oderbruker barley gave the largest yield per acre, but was somewhat lighter in weight per measured bushel. Siberian and Daubeney oats gave the best yield of grain, per acre, and Russian No. 2800, the best yield of straw. Daubeney ripened earliest and most evenly. Russian spelt did not produce a good crop of either grain or straw. Russian vetches grew luxuriantly and produced a large amount of fine green forage.

Horticultural Experiments

Prof. Goff gave a preliminary report on experiments on the effect of pinching raspberry shoots. In young plantations of the Gregg and Cuthbert raspberries, pinching the shoots at 24 inches high was found beneficial to the yield, but at 12 inches, it was of very doubtful value. Pinching the lateral shoots was not beneficial to the yield. Pinching increased the growth of superfluous shoots, and in the Cuthbert variety, of suckers. It also increases the cost of covering for winter protection.

Investigations, by Prof. Goff, regarding the comparative hardiness of flower buds of the cherry, showed that centrally located buds contained a larger percentage of live embryo flowers than those near the ends of the branches. The percentage of live embryo flowers increased as the number of flowers in the bud diminished, on the same tree, and in different varieties. There was no marked difference in hardiness between the basal and more terminal buds in the fruit spur. Protection of the cherry orchard from prevailing winds, in severe weather, by a windbreak, was advised as a preventive of flower-bud destruction. Varieties of the Morello species of cherry, having comparatively few embryo flowers in the flower buds, would be likely to prove hardier than those in which the number is comparatively large.

During 1898-1899 Prof. Goff undertook an investigation to ascertain the time of the origin, and the rate of progress of the flowers of the cherry, plum, apple and pear. The method of treating and examining the flower buds at different stages of their development was explained and the results attained reported in the 16th annual report of the Station. Illustrations accompanied the text. Of the conclusions arrived at, it may be mentioned that in the apple and pear the terminal flower was found to be most rapidly developed, and to expand first. In the plum and cherry, however, the proximal flower is probably developed slightly in advance of the others. Evidence deduced from the examination of a large number of flower-buds indicated that the pistil in the plum and cherry appears to be formed from a single part, the edges of which ultimately grow together, forming the ovary. No light was thrown on the primary cause or causes of the formation of flowers. Relative to conditions that affect the formation of flowers, it appeared that the environment of fruit trees, during early summer, may be quite as potent in determining what the fruit crop of the following year will be, as that during late summer.

Prof. Goff also studied the influence of heredity upon vigor in the potato and considered the results sufficient to demonstrate the principle that vigor in the potato plant, as in other plants, may be maintained and increased by selection. To that end, he suggested that where the digging machine is used, a good plan would be to grow a plot of potatoes each year on the best soil, to be used expressly for seed purposes, and to dig the potatoes on this plot by hand. The selected tubers from the plot could be used the next season to produce the seed for the main crop the following year. This is, substantially, the method practiced by seed growers in maintaining the vigor and purity of their seeds.

F. Cranefield made tests relative to the preservation of fruit for exhibition. He desired to find a method that would preserve the color as well as the form of the fruit. After many trials, a mixture of formalin, 2 per cent, alcohol, 20 per cent, and water, 78 per cent was found best suited for the purpose.

Chapter X

Dr. Babcock Appointed Assistant Director and Prof. R. A. Moore, Agronomist

Dr. Babcock appointed Assistant Director

In the Seventeenth Annual Report for the fiscal year ending June 30, 1900, Director Henry announced that all of the research workers of the Experiment Station had remained at their posts and continued their investigations. The Board of Regents had appointed Dr. S. M. Babcock, so long chief chemist, to the position of Assistant Director of the Experiment Station. In recognition of his services, Dr. Babcock had also been awarded the grand prize of honor by the French Government, at its Universal Exposition, held in Paris.

It was Director Henry's intention to ask the next legislature to provide a new Agricultural Building to be erected in close proximity to the Dairy and Horticultural - Physics buildings. The central heating plant had been completed, and a structure nearly completed, to provide accommodations for investigation and instruction in cheese making.

Prof. R. A. Moore was placed in charge of Agronomy work. The names of U. S. Baer, dairying, and F. Dewhirst, assistant in dairying, appeared in the list of officers of the Station. During the year, eight regular bulletins were issued, and a second edition of Bulletin No. 75, on the testing of dairy cows was published. Including the annual report they comprised 651 pages of printed matter, and, in all, more than eleven million printed pages in the form of reports and bulletins, were distributed from the Station, nearly all going to the farmers of Wisconsin.

Notes on the eight bulletins follow:

Control of Noxious Weeds

The text of the original Wisconsin weed law having been modified in some important respects, the law was republished in its ammended form in Bulletin No. 76, of July 1899. In that publication, Prof. Goff also gave illustrations and descriptions of some of the most prevalent and injurious weeds. He regretted that the weed law had not been more generally enforced, and mentioned, as a matter of interest, that all of the weeds condemned in the law were introduced into this country from Europe. General hints were given for their suppression. To lists of weeds previously published were added, wild carrot, chicory, morning glory, horse nettle, buffalo bur, prickly lettuce and long-leaved plantain.

In Bulletin No. 77, of August, 1899, Prof. Goff reported the effects of the February freeze of 1899, upon nurseries and fruit plantations in the Northwest. At the time of the cold wave a large part of the region commonly known as the "Northwest" was without the usual winter covering of snow. In consequence, the ground froze to a depth never before experienced in many localities. Evidences of frost injuries upon fruit trees became most apparent when the frost left the ground in April. In some nurseries and young orchards, scarcely a fruit tree could be found that had living roots, and hundreds of acres of land, that a year before were covered with promising nursery stock, had to be charred off and planted with other crops. Experience gained by study of the ill-effects of the great freeze of 1899, led Prof. Goff to advise that nurseries, so far as possible, should be planted on north slopes, and that evergreen wind-breaks, extending east and west, should be interspersed in nursery blocks, to promote retention of snow covering. He also recommended that orchard and nursery grounds be kept free from weeds and well cultivated until July 15 or August 1 and then be sown with oats or buckwheat, peas, vetches or mammoth clover, to serve as a litter covering. Where mice were to be feared in winter, corn soaked in a solution of strychnine, should be scattered on the ground late in autumn. The sowing of mammoth clover should be done only in wet seasons, and in orchards, as it would commonly need to be plowed up the following spring. The loss from root-killing might, probably, have been reduced at least one-half had the crab apple been generally used for root grafting the apple in the northwest. The plum should be worked on Americana seedlings and the cherry on Mahaleb stock, rather than Mazard, until a satisfactory stock, more hardy than either, could be formed. The roots of the blackberry being especially tender, ~~All~~ all possible precautions should be taken for their protection. A covering of straw or other litter would be a wise protection for open winters.

A Tuberculous Herd of Cows

In Bulletin No. 78, of August 1899 Dr. Russell told the story of a thrifty farmer's sad experience with bovine tuberculosis. To improve his herd of dairy cows he had bought and introduced some pure bred cows, and with them introduced a microbe, which, later, was to increase and spread throughout his herd to such an extent as to seriously threaten the success of his whole enterprise. The germ in question was that of tuberculosis. He had been unable to determine whether any of his cows was affected or not. In 1895, some of the purchased cows began to fail, and in that and the following year two of them died of what, later, was found by post-mortem examination to be tuberculosis. Then the entire herd was tuberculin tested, under the direction of the Experiment Station, and 13 out of the 16 mature cows reacted. Three head of young stock also responded to the test. This occurrence might have been prevented by tuberculin testing the original pure bred cows and rejecting ~~repeating~~ the reactions. Dr. Russell explained the contagiousness of the diseases, what should be done when its presence is discovered. Control by quarantine, disinfection of the barn, and other informative matter on the subject.

Construction and Care of Country Roads

Senator J. H. Stout, of Menomonee, Wisconsin, initiated improved road building in the State, by constructing at his own expenses, in 1898, a section of model road in the vicinity of his own town. It was intended to serve as an object lesson and an inspiration to the better construction ~~constructive~~ and maintenance of city and country roads. The services of Special Agent E. G. Harrison, of the U. S. Department of Agriculture, were secured to supervise the construction. The Experiment Station assisted in the educational phase of the matter, by presenting, in Bulletin No. 79, of September 1899, photographs and full particulars about the road building, and the results of the effort, for the benefit of the citizens of the State. The Bulletin was prepared by Prof. King, and included much useful and needed information about all phases of road-building. In its concluding paragraph, he advised that there should be a State Commissioner or Superintendent of Roads, whose duties should be to unify and coordinate the work throughout the state, and subordinate to him should be county -

Road Engineers who should have immediate supervision of road construction in their respective counties. Subordinate to the county road engineer, there should be the City Road Engineers, for cities above a certain size, and District Road Masters for the country and small towns, having for their duty the maintenance of country roads.

Treatment of Swamp Soil

Prof. King, and his assistant J. A. Jeffery, drew attention in Bulletin No 8, of January 1900, to the fact that in the State of Wisconsin there are, approximately 2,700,000 acres, or in round numbers, 4,000 square miles, of land covered with humus soils. The soils of this type are usually black in color, mellow, easily worked, high in percentage of water, rich in nitrates and well supplied with phosphates and potash. They have also more lime and more magnesia than most soils, and the content of humus is very high; yet a good dressing of coarse farmyard manure usually increases their productiveness in a remarkable degree. The authors discussed the behavior of crops on humus soils. Experiments with commercial fertilizers, in 1896, had shown that only those containing potash materially improved the yield of corn. Potassium carbonate, sulphate and nitrate and woodashes greatly improved the corn crop, but potassium chloride, in one-half the quantity of the other salts, killed the corn. Oats and hay were liable to lodge. Winter killing of clover was very common. Timothy and red top do best of the grasses. The soil, when drained, is easy to work and maintains an excellent tilth. Results of several experiments were reported.

In Bulletin No. 81, of April 1900, Woll and Vivian published, in accordance with the Wisconsin Statutes of 1898, Section 1494 d., the results of the analyses of commercial fertilizers licensed to be sold in the state during the current calendar year.

Grinding with Small Steel ~~Fed~~ Feed Mills

King and Jeffery, in 1900, conducted experiments to determine the rate at which feed for livestock may be ground with several types of small steel mills then on the market; the power required to run them; and the approximate cost of grinding. They gave the results of their work in illustrated Bulletin No. 82, of April, 1900. All of the grinders tested were of the metal type, using steel burrs. Eight different machines were tried. It was found that as an average of all the grinding trials with a 5 horse-power engine, the cost of fuel per day was \$1.7~~2~~75 and for a 2½ H. P. engine \$.885. This is at the rate of 3.55 cents and 3.54 cents per horse power, for fuel, where gas costs \$1.25 per 1000 cubic feet. The average amount of corn ground per horse power, per hour, was 4,822 bushels, equal to 270 lbs., and this is 2,700 lbs. per horse power for a 10 - hour day. The most rapid grinding of corn, done with a 12 foot roller-bearing aermotor windmill and grinder, was at the rate of about 25 bushels per hour, with a wind velocity of 31.8 miles. When grinding with steam power, the fuel cost for oats was more than 3 times that for corn, and that for corn and oats and for rye nearly the same, and about two-thirds more than for corn. Bulletin 82 gave full particulars on all phases of the grinding problem.

Silage and Silo Building

In Bulletin No. 83, of May 1900, Prof. King announced that "we have now obtained a sufficient body of sound knowledge upon which to build a safe and economic practice in the handling of silage". He also said that the verdict was practically unanimous among all dairymen, who have fed good silage", that it is the best winter feed they ever used as a substitute for hay or corn fodder, and that they would not think of doing without it!" Many silos had been improperly constructed and did not give satisfaction; therefore Prof. King examined more than 200 silos to discover the errors made, and devise a plan of silo construction which would avoid them and secure a better quality of silage. One-half of the silos were visited in 1889-90 and these examinations and the experience gained from seven years of experimental studies, had led to adoption of the cylindrical silo which was now being extensively built and giving general satisfaction. Illustrated Bulletin No. 83 presented the facts gathered on the subject, and contained plans and detailed instructions for the construction of the modern silo. The painstaking, scientific and practical work done by Prof. King, and his bulletins regarding silo construction and silage, were of immense value to the dairymen of Wisconsin and will lastingly rebound to his credit and esteem.

Animal Feeding Experiments

The report for 1899-90 contained an account of the continued work of Director Henry in comparing whole corn with corn meal for fattening swine. The report was elaborately illustrated, the pictures showed vertical and cross sections of Poland China, Berkshire and Yorkshire pigs, to exhibit the distribution of fat and ham in the carcasses resulting from different rations.

Prof. Carlyle again reported on feeding trials of rape as a foraging crop for swine. The experiment showed that a ration of rape alone, fed to pigs for 2 weeks, is not sufficient to supply the food necessary for their support. Rape proved, however, of much higher value as an adjunct to a grain ration. He also experimented to determine the comparative feeding value and effect upon lambs of feeding corn fodder with bran and oats; corn fodder and corn silage with bran and oats; corn silage and hay with bran and oats; and roots and hay with bran and oats. Tables of results accompanied the text. Well cared corn fodder with about 65 per cent of the ears removed, fed in conjunction with .5 lbs. of a mixture of equal quantities of bran and oats to pregnant ewes proved very cheap and entirely satisfactory, as did corn silage, along with either corn fodder or mixed hay, bran and oats. Hay and roots proved a very expensive ration, and not better than those just mentioned. Too much corn caused detrimental fatness in breeding ewes.

Professors Woll and Carlyle continued their experiments relative to the economy of heavy grain-feeding of dairy cows reported in the 16th annual report. The results of the new tests corroborated those obtained from the previous experiments. The general conclusion was that it does not pay to feed dairy cows more than about 8 lbs. of grain feed per head daily, except in the case of cows of marked dairy tendencies that respond to heavy grain feeding by an increased production of milk and butter fat, rather than by a gain in weight. The experiments were to be continued.

Prof. Woll reported official tests of dairy cows made in 1899-1900, and gave directions for conduction of such tests. Thirty-five different tests were made in all, varying in length from 2 to 14 days. The number of cows tested was 132 for 16 different breeders. The average cost of a 7 to 8 day test, to the breeders was $19.44.

Prof. Woll also experimented to determine the source of error in some Babcock tests of the turbine type. His analyses showed that the error in tests made in hot turbine testers was most noticeable when samples of cream are tested. The fat content in rich cream, so tested, might show an error approaching 1 per cent too high, the error increasing with the richness of the cream. The temperature should not exceed 140-150 degrees Fahrenheit. He advised that if the fat column in the neck of the test bottle sinks rapidly when it is taken out on completion of the test, or if the bottles are too hot to be held in the hand without difficulty, the readings are likely to be from one - to two-tenths of 1 per cent too high; with milks of ordinary quality, and in such cases the fat should be allowed to cool to about 140 degrees before readings are taken.

Tests made by Prof. Farrington, together with those of Prof. Woll, showed that the turbine tester, in which bottles are heated to 200° F., give too high results when whole milk is tested, but more nearly correct results on skim milk. The turbine tester, however, which has an opening in the cover, so that the temperature does not rise much above 140° F. gives results too low on skim milk, but correct with whole milk. Prof. Farrington also found that a few changes in the ordinary manipulation of the Babcock test make it possible correctly to estimate the percentage of fat in sweetened condensed milk.

By use of a specially constructed test bottle with two necks he was able to syphon the sugar solution out of the test bottle, after the curd had been separated by addition of a few drops of acid. After this was done a clear separation of the fat was obtained by completing the test in the usual way. Further tests showed that the extra side tube or neck was superfluous, and that the whey could be poured off from the curd through the graduated neck of the test bottle, as safely as it was syphoned through the side tube. This was made possible by whirling the test bottles in a steam heated centrifuge at such a speed that the curd was cooked with a rather hard lump which did not break when the whey was poured off. A description of the manipulations adopted for the method was given in the 17th annual report of the Station.

Relative to the calculation of dividends for milk and for cream at the same factory, Prof. Farrington, in the annual report just mentioned, prescribed the proposed procedure to be followed by the factoryman. His explanation concluded with the statement that when both milk and cream patrons come to one factory, the weight of butter fat, found by testing the cream, should be multiplied by 1.03, the result obtained to be regarded as the total amount of fat delivered by the cream patron.

Prof. Farrington and Frank Dewhurst, with the help of dairy students, tested the Columbia air churn which had been advertised by its makers to have "completely revolutionized the old method of churning"! It did not compare favorably with the ordinary barrel churn. The average test of the buttermilk from it was .77 per cent of butter fat, and from the barrel churn .26 per cent fat. Instead of taking but five minutes for a churning as claimed by the makers, it took 26.7 minutes, against 28 minutes for the barrel churn. There was a difference of 4.06 per cent in favor of the barrel churn in the amount of butter it made from a given amount of cream compared with that from the air churn and the latter cost $3.00 more than a barrel churn of the same size, and was difficult to keep clean and in repair.

Alfred Vivian tested Fitch's rapid method of estimating the percent of salt in butter, and explained how it should be applied. He found that, with care, the method is capable of giving results very close to those obtainable by the official method. The tablets used in the test consisted of 0.0509 grams of silver nitrate, combined with sufficient potassium nitrate to make a tablet weighing 5 grains, a trace of gum acacia being used to bind the materials together.

Doctors Babcock and Russell, and A. Vivian, reported various test to determine the influence of rennet on cheese ripening. They found that an increase in the amount of rennet extract used increases the amount of the soluble nitrogenous products, which measure the progress, but it does <u>not</u> increase the water content of cheese and therefore, the ripening of cheese can not be indirectly affected in that way. The increase in soluble nitrogenous products in cheese and in milk, due to an increase in the amount of rennet extract used is confined to those by-products that are peculiar to pepsin, and attributable to the action of pepsin incorporated with the extract. They concluded that rennet exerts a digestive effect on the casein of cheese, due to the presence of peptic enzymes contained in rennet extracts, the action of which is intensified by development of acid in the curd. The soluble nitrogenous products formed in Cheddar cheese by rennet are the albumoses and the higher peptones that are precipitated by tannin.

Doctors Babcock and Russell contributed a paper on the causes operative in the production of silage. They discussed the cause of initial heating; the effect of direct respiration on heat production; effect of wounding tissues on heat production; production of heat in absence of oxygen; and by fermentative organisms; origin of gases in silos; asphyxiation from carbonic acid gas; analyses of silage gases; relation of initial heating to silage formation; causes of changes in the formation of silage and influence of maturity of corn on quality of silage. He concluded that the initial heating of silage is due mainly to the respiratory processes of the cut plant tissues themselves, and not wholly to the action of bacteria as previously believed. The generation of a high degree of heat was not found essential to production of good silage. Silage from immature corn is not only higher in acidity, but putrefactive changes are caused in it by bacteria capable of developing in the more succulent tissues, where air is excluded. It was advised that greater care should be exercised in the construction of air tight silos, and in the selection of fodder of proper maturity, so as to eliminate the avoidable losses, and reduce to a minimum those inherent changes incident to the protoplasmic process in silage.

Doctors Babcock and Russell also devised an apparatus in which a closed circuit permitted a limited quantity of gas to be used, over and over, with or without the addition of any volatile substance, and used it in their investigations relating to respiration of vegetable tissues, and the study of the influence of various volatile plant poisons. An illustration of the apparatus appeared in the 17th annual report, together with explanatory notes.

Dr. Russell proved, by a series of experiments, that an exposure of tuberculous milk in a tightly closed commercial pasteurizer for a period of ten minutes destroyed, in every case, the tubercle bacillus. Pasteurization is most perfectly accomplished in a closed receptacle, than where the milk is heated in open bottles or open cans. It should be heated for a period not less than twenty minutes at 140°F. in a closed container.

An outbreak of contagious disease which occurred during July and August, 1899, on several farms on Black River, below Medford, Wisconsin, was found by Dr. Russell to be due to the bacillus of anthrax, traceable to refuse from a tannery carried onto low pastures by the river water. He gave full information about the disease, its nature and prevention. E. G. Hastings, in the same paper, published in the 17th annual report of the Station, also reported the results of experiments made by him with formaldehyde as a destroyer of the disease spores on hides. He found that solutions sufficiently strong to destroy the spores would injure the hides; but it would be possible for tanneries to disinfect the refuse by chemical treatment, and thus render it innocuous. Farmers living on farms bordering the stream which might carry anthrax infection, were advised to keep their stock vaccinated against the disease by the Pasteur method.

Prof. King presented summaries of experiments he had continued relative to the right amount and distribution of water in crop production, and regarding unavoidable losses in silage.

Profs. King and Whitson reported more extended studies of the influence of potash salts on black marsh soils. Untreated soils gave yields of only about one-half those from treated soils. The potash salts, when applied to the surface for corn, produced the least increased yield. Used at a depth of three inches, they gave the largest general yield, a nine-inch depth rating next. Corn from untreated soil showed, on analysis, .83 per cent, and that from treated soil 1.03 per cent of potash in the dry matter. Kainite, sulfate and muriate of potash, applied in other experiments, materially increased the growth of millet, tobacco and cabbage.

King and Whitson also continued their study of the soluble salts of cultivated soils, reported the previous year. Their report on the subject in the 17th annual report was illustrated by graphs and brought out many interesting conclusions. They found, among other things, that nitrification had taken place at all depths down to three feet below the surface. Twenty-two per cent more nitric nitrogen developed from soil after clover than from the soil after corn, and 13 per cent more than from that after oats, during the 93 days of the tests. The fertilizing power of clover appeared to depend more upon the amount of nitrogenous material left in the soil, which is capable of rapid nitrification, than upon nitric nitrogen accumulated in it.

Prof. Moore continued his tests of grain varieties, on a larger scale than in 1899. He also tested varieties of vetbh and made a comparison of Victoria rape with Dwarf-Essex rape. Swedish, Poland White and Tobolsk oats gave the best results, and were considered most suitable for Wisconsin conditions as were Oderbrucker and Mandshury barley. Spelz gave better results than in 1899. Ravages of the pea weevil made peas a very uncertain crop in the Madison region. Sowing of half the usual quantity of oats, per acre, on rich soil, prevented lodging of the crop. The formaldehyde treatment proved effective as a preventive of oat smut. Dwarf Essex rape gave heavier yields of forage than the Victoria Variety. Black, yellow and green soy bean varieties were tested, of which the black and green ripened and produced fully matured seed, while the yellow variety did not mature seed. Experiments with soy beans were to be continued.

Prof. Woll continued his studies of problems connected with the culture of sugar beets in Wisconsin. His report presented a map of Wisconsin, showing the average quality of sugar beets in the different counties from 1890 to 1899. The studies were to be continued.

Woll and Vivian reported analyses of licensed commercial fertilizers made in 1899.

Prof. Goff gave a further account, in the 17th annual report, of the investigations he had continued regarding fruit buds, the effect of pinching raspberry shoots, the resumption of root growth in spring, and the duration of the growth period in fruit trees.

Prof. Farrington offered a description of the new cheese curing room, and of the foreign cheese making rooms which had been equipped ~~in~~ the Dairy building. Previously, the cheese rooms had been provided only with facilities for giving instruction in Cheddar cheese making. Plans accompanied the description.

Prof. Carlyle again presented an illustrated report on the records made by the Station dairy herd. In it, he mentioned, among other interesting facts, his surprise, and that of herdsman J. R. Danks, at the large amount of milk and butter given by the heavy grade Shorthorn cows of the dual-purpose type. One of them yielded, during the year, 7,996.7 pounds of milk and 322.1 pounds of butter fat, or 364.36 pounds of butter. The profit over the cost of her feed was $57.48, while the previous year it was but $20.86.

Chapter XI

Dr. Babcock Honored in 1901

Doctor Babcock Honored (1901)

The legislature of 1899 had provided that a medal be presentd to Dr. S. M. Babcock, in recognition of his scientific services to the people, and the presentation was made on the evening of March 27, 1901. An account of the proceedings was given by Director Henry in the Eighteenth Annual Report, for the year ending June 30, 1901. The medal was made by Spink & Son, of London, England, the makers of royal seals; and was the largest medal ever struck in England, up to that time. It was of golden bronze, 5 inches in diameter. On one side were symbolical figures representing Agriculture and Science, bringing offerings to the State, represented by a personage enthroned on a raised dais. On the reverse were printed the following words: "Recognizing the great value to the people of this state and to the whole world of the inventions and discoveries of Professor Stephen Moulton Babcock, of the University of Wisconsin, and his unselfish dedication of these inventions to the public service, the State of Wisconsin presents to Professor Babcock this medal".

The presentation services were held in the Assembly Chamber, at the Capitol, at a joint session of the Senate and Assembly, presided over by Governor Robert M. LaFollette. The presentation address was delivered by Regent Ogden H. Fethers. Other addresses were made by Governor LaFollette, Assemblyman C. W. Gilman, Senator W. H. Halton, and Director W. A. Henry, who represented the University. Doctor responded, and there followed an eloquent address by Hon. W. D. Hoard.

The great medal presented by the Wisconsin Legislature of 1899, and other medals received during his career, were intrusted to the Historic Library, by Dr. Babcock, for safe keeping and exhibition.

With deep regret Director Henry announced the resignation of Prof. F. H. King, chief of the department of Agricultural Physics, who had been placed in charge of a division of the U.S. Department of Agriculture, Washington, D.C. Prof. A. R. Whitson assumed the position vacated by Prof. King. Prof. Woll, chemist of the Station, being absent in Europe, R. H. Shaw, previously Assistant Chemist of the New Hampshire Experiment Station, assumed his work. T. F. McConnell, Jr. was made an instructor in Animal Husbandry. DR. A. G. Hopkins, veterinarian, resigned early in the year, to undertake agricultural journalism in Canada. E. G. Hastings, Assistant in Bacteriology left, to study his specialty in Europe, and John F. Nicholson, a graduate of the University of Wisconsin, took his place. Frank Dewhirst, instructor in Dairying resigned, to engage in business.

The legislature of 1901, appropriated $150,000 for the erection of Agricultural Hall, and it was hoped that the building would be completed during the winter of 1903. The next legislature was to be asked for funds for its equipment and furnishing.

At the Station farm, the farm house, superintendent's cottage and the old dairy building, had been moved to new locations, and put in first class condition.

During the year ending June 30, 1901, Bulletins Nos. 84, 85, 86 and 87 and 3 special bulletins were issued. Director Henry announced that pages printed by the Station during 1900-1901 numbered 6,627,000, in the form of reports and bulletins, nearly all going to the farmers of Wisconsin. The three special bulletins mentioned were entitled: The Prevention of Oat Smut, March 1901; Canker Sore Mouth in Young Pigs, May 1901; and Directions for Growing and Feeding Rape, May 1901. In the bulletin on canker Prof. Carlyle advised immersion of pigs' heads, at birth, in a solution of potassium permanganate as a preventive of canker and gave advice relative to the maintenance of sanitary conditions in hog pens.

Combating Bovine Tuberculosis

Following the initial use of tuberculin in the Experiment Station herd, Dr. Russell began an active campaign against the disease in Wisconsin. His bulletins had informed cattle owners regarding the prevalence and menace of the disease and had explained the nature of tuberculin, its effects upon animal tissues, and its use as a means of detecting the disease. To further the introduction of the test among the farmers of the state, he had caused tuberculin, furnished by the U.S. Department of Agriculture, to be distributed, and had instructed agricultural students how to test their own herds. As a result, nearly 1,250 animals had been tested. The results were published, by Dr. Russell and Prof. E. G. Hastings, his assistant in bacteriology, in bulletin No. 84 of March, 1901. Through the courtesy of Dr. H. P. Clute, Wisconsin State Veterinarian, reports of part of the testing work done under his auspices, were included in the bulletin.

Among herds believed to be tuberculous, practically one-third of all the animals tested by the state Veterinarian and Station experts reacted. Of nearly 1,000 animals not suspected of the disease, with the exception of three or four herds, none, to one to five per herd, reacted. Out of 42 herds of this class examined, 22 were entirely free, and 8 had only 1 or 2 affected animals. In no case did a physical examination reveal presence of the disease in a manner at all comparable to that shown by the tuberculin test. The authors suggested that calves from reacting cows might, in almost every instance, be raised in a perfectly healthy condition, by removing them from the dam a day or so after birth, and feeding them upon boiled or pasteurized milk, or that of a non-reacting cow. They also advised that the veterinary laws should be revised, so that the owner of reacting animals might have the option of retaining valuable cows, under quarantine, in order that from them healthy progeny might be raised, the milk of such animals to be pasteurized. They further advised that partial compensation, for the destruction of affected animals by the State, should by continued, provided the infected quarters had been thoroughly and efficiently disinfected to kill disease organisms present in the barns, and that the law should require that all cattle imported for breeding or dairy purposes should be subjected to the tuberculin test, before shipment, or as soon as they were brought into the state.

Nitrates in Cultivated Soils

In 1900, Profs. King and Whitson continued the research work relative to the development and distribution of nitrates and other soluble salts in cultivated soil which they had previously reported in the 16th Annual Report. The work summarized in Bulletin No. 85 was done under better conditions, and conducted more systematically and extensively. They found that the nitrates and total soluble salts in the surface foot of soil increase in amount during summer, lessen until August 1 and afterward remain nearly constant, with a slight rise until September. Little change was noted in the lower layers of soil. The salts mentioned were much less in amount in the soil under clover and oat crops, than those under corn and potatoes, throughout the season. In corn, especially, the largest yields of dry matter were associated with the largest total amounts of soluble salts.

Frequent cultivation of soil increased the amount of nitric nitrogen. Cultivation four inches deep gave a smaller nitrification than three inch culture. Clover and alfalfa appeared to hold the nitric nitrogen in soil down to a lower limit than corn, oats and potatoes; but after removal of the crop, nitrification proceeded faster in the clover and alfalfa soil. Many other interesting results were reported in the bulletin and elaborate tables and graphs accompanied the text.

The analyses of licensed commercial fertilizers, made in 1901, were reported by Prof. Woll in Bulletin No. 86 of March, 1901; and in illustrated Bulletin No. 87 of April, 1901, Prof. Goff published matter relative to native plums supplementing Bulletin No. 63 of October, 1897, on the same subject. Cultural notes, notes on varieties, the culinary uses of native plums, investigations and experiments, were the subjects considered.

Director Henry, in the 18th annual report, gave the results of further trials with whole corn, compared with cornmeal, for fattening swine, similar to those summarized in the five previous reports. Some of the hogs used in the trial were "Razor-backs" crosses by an Indian Territory feral or "wild" boar. During the experiments conducted for six years, 192 hogs had been used. In all instances, some wheat middlings had been fed as a part ration with the corn. In seven cases, there was a saving through grinding the corn to meal, while in two cases there was a loss. The highest saving was 17.6 per cent, and the lowest, two per cent. The highest loss was 9 per cent, and the lowest, 2 per cent.

Prof. Carlyle reported further experiments regarding the comparative value and the effect upon the lamb crop, of feeding various rations to ewes during the winter. He found that a ration of corn fodder, corn stover and 1-2 pounds of equal parts of bran and oats per ewe per day, for 12 weeks before lambing, was a satisfactory food, so far as physical condition of the ewes was concerned; but it induced a poor flow of milk and the lambs produced were smaller in size with a larger proportion of weak and dead ones at birth than those dropped by ewes on more complete rations. A ration of corn stover and corn silage, with 1-2 pounds per ewe daily of bran and oats, was entirely satisfactory, both for the ewes and also their lambs. So was a ration of corn silage, hay, and the grain mixture. A ration of roots and hay, with the grain mixture, was less satisfactory, the ewes milking poorly and a number of their lambs being weak and affected with goiter. He concluded that corn silage was one of the cheapest and most satisfactory foods for breeding ewes in winter, and that a ration containing corn fodder as the sole roughage was not entirely satisfactory.

Prof. Carlyle and T. F. McConnell McClonnell continued in 1900-1901, the experiments reported in the four previous annual reports relative to the effect of feeding various grain rations to growing and fattening hogs. Their report was accompanied by numberous illustrations showing types of hogs fed, and by vertical and cross-sections of their carcasses, showing the distribution of lean meat and fat. They proved, by two experiments, that a ration of peas and shorts gave a larger proportion of lean meat, firmer flesh, and stronger bone and more blood than one composed of corn and rye. Peas, compared with corn, gave more marked results in those respects, than did a ration of peas and shorts, when compared with one of corn and rye. A ration of corn and corn and rye, fed to growing pigs, tended to retard development of their internal organs, and to increase the proportion of fat. The thigh bones of pigs fed on peas and corn were, on the average, 26.9 per cent stronger than those of pigs of the same age and breeding, that were fed on corn. Peas were, however, much more expensive than corn.

Prof. Carlyle concluded, from continued experiments that rape is the most satisfactory and cheapest green feed for swine that he had fed.

Notes on a thesis submitted by F. D. Taylor, for the degree of Bachelor of Science in Agriculture, and pertaining to the food requirements of the pig for maintenance and gain, were published in the 18th annual report of the Station. William Dietrich had done similar work for a thesis, as mentioned by Director Henry in the previous annual report. The results of the experiments were similar.

Prof. Woll and Roscoe H. Shaw reported the results of official tests of dairy cows made during 1900-1901. One hundred and thirty cows, belonging to 15 breeders, were tested. All were Holsteins and Guernseys. Tables showing the records made, accompanied the text.

Prof. Farrington again contributed an illustrated paper relative to the annual milk and butter production of cows owned by patrons of the University creamery. The milk handled at the creamery ranged from 3,000 to 13,000 pounds per day, except Sundays. The larger amount came from 95 farms in May and June 1901.

Prof. Farrington also reported on a simpler way of inspecting the graduations of milk test bottles, proposed by O. A. Trowbridge, a creamery butter maker of Columbus, Wisconsin. The method was explained and had been found entirely correct in principal, and a valuable contribution to the Babcock test apparatus. A slight modification of the original Trowbridge idea, made by the Louis Nafis Company, of Chicago, in the form of an instrument which will test the 5 per cent mark of the scale, as well as the 10 per cent mark, was also tested and found satisfactory.

Print butter having made a favorable reputation, Prof. Farrington experimented to determine the possibility of applying the idea to the manufacture of cheese. After studying the question for two years, he announced, in the 18th Annual Report, "that this new form of cheese can be made, and that it is received with much favor by the consumer". The method of making the print, in a special mold making an impression of the letters U. W., in raised letters, was explained and the prints illustrated. Prof. Farrington did not patent his process, and it was favorably commented upon by manufacturers as a promising possibility in cheese making.

Cold Curing of Cheese

Doctors Babcock and Russel, A. Vivian and U. S. Baer summarized, in the 18th Annual Report, the results of four years of experimental work relative to the influence of cold-curing on the quality of cheese. Previous results have been recorded. A new series of experiments was begun by U. S. Baer during the current year. Cheese, cured at the usual curing temperature (60° F.) were, for the first few months, of excellent quality, but when placed in the new underground curing cellars, at the Dairy building, before complete drying had taken place, were injured in quality by the excessive moisture and, at five months, were discarded as unfit for use. The cheese cured at 40° and 50° F. continued to improve with age and, at five months old, were practically perfect in texture; but a little low in flavor. Those kept at freezing temperature (15° F.) while partially broken down to the touch, had a soggy, curdy texture, and entirely undeveloped flavor. It was concluded that temperatures ranging from 40° - 50° F. may be employed with perfect safety for the curing of Cheddar cheese, even when the cheese are placed at those temperatures directly from the press. In no case did the cheese so kept develop a sharp, bitter, or disagreeable flavor. While the flavor was somewhat mild, the texture of the cheese was beyond criticism. The indications from the entire series of tests were that the ordinary temperatures, secured in cold storage rooms, are suitable for cheese curing. The report gave a summary of the entire work done relative to cold curing of cheese, and explained how the system might be applied in consolidated curing plants.

Doctors Babcock and Russell, with A. Vivian and E. G. Hastings, reported experiments which showed that when the sugar of milk was removed by dialysis at a low temperature, the growth of bacteria was very rapid, at a temperature of 37o C. resulting, without an exception, in the production of putrefactive products, instead of the lactic acid usually formed when milk is allowed to undergo a spontaneous change. The tests indicated that milk sugar either directly or indirectly prevents milk from undergoing putrefactive changes, and explained why milk does not putrefy like other organic solutions rich in protein. When sugars, such as glucose and saccharose, were added to dialyzed milk, they soured in two days with no disagreeable odor, whereas in the case of dialyzed milk having no addition of sugar, curdling occured in a few days, with the production of a foul odor. That sugar exerts an inhibiting effect on putrifaction of protein matter, was further proved by the action of minute quantities in preventing the formation of indol in bacterial cultures. It was also found that the removal of sugar markedly affects both the flavor and texture of cheese. The addition of sugar prevented the development of objectionable flavors in cheese, that occur when the curds are washed. The addition of sugar also gave firmness to the curd, making a closer texture, and restoring to the washed curd, the translucent yellowish appearance that normally appears in ripening cheddar cheese. It was concluded that the type of bacteria which develops in milk and cheese is largely controlled by the sugar contents.

In the 17th Annual Report, Doctors Babcock and Russell had advanced the hypothesis, based upon their experiments, that the causes operative in the formation of silages were explicable on the assumption that the changes taking place were inherent to the plant cell itself, and were largely the result of the respiratory activity of the protoplasm of the plant tissues, rather than the action of bacteria. In the 18th Annual Report they summarized further experiments, made to test the validity of this hypothesis. The second series of tests reported added to the probability of the conclusion, already drawn, that the internal processes of the living plant cell are the factors that inaugerate the series of changes which results in the production of typical silage.

In the 17th Annual Report, Dr. Russell and E. G. Hastings stated that tests, by them had shown that the tubercle bacillus was more resistant in milk when heated in open than in closed vessels, this variation being attributed to the formation of the surface pellicle ("scalded layer") on milk heated in open containers to a temperature of about 140° F. (60° C.) or above. They made a special series of experiments in 1900-1901 to determine why the destruction of bacteria in milk is subject to so much variation and gave the results obtained, in the 18th Annual Report. A micrococcus isolated from pasteurized milk, which possessed the unique property of retaining its vitality at temperatures considerably above 140° F., was used in the tests in bouillion, milk and whey. They concluded that the relation of the surface membrane or "pellicle" to the varying vitality of milk, is shown by the growth of organisms in the membrane at higher temperatures than in the milk below, and by sterility of the membrane removed, after an initial membrane has been formed. The increased resistance of bacteria in the surface membrane was considered not entirely due to lowering of temperature at the surface but, apparently, to the effects of the nature of the enclosing membrane itself.

Prof. King again reported on the influence of the right amount and the right distribution of water in crop production, and gave a second report on the influence of close packing of corn in the silo on the unavoidable losses in making silage. Close packing was found to reduce unavoidable losses to an appreciable extent. The more loosely silage is packed in the silo, and the larger the volume of entangled air, the greater will be the unavoidable losses. It was advised that a metal covering, making a silo nearly air tight when filled and closed, would lessen losses by preventing, what Prof. King designated, "silage breathing".

Prof. King and A. R. Whitson in 1900-1901 continued their nitrate studies and those of black ~~moist~~ marsh soil, of the previous season. Among other results, they concluded that the increase of nitrates in the late fall plowing, after the frost went out, as well as in that not plowed, was probably due to differences in the amount of water brought up by capillarity from below the level of 4 feet: but that the larger amounts of nitrates which had accumulated under the early fall plowing, as compared with the ground not plowed, was due chiefly to more rapid nitrification, resulting from better conditions maintained by plowing. The tests with fertilizers in black marsh soil corroborated the conclusion, reported in Bulletin No. 80, to the effect that the addition of potassium salts is very beneficial.

Prof. Moore announced, in the 18th Annual Report, that the Station would be unable to distribute seeds, as the supply on hand would be needed for other experiments. His experiments, for 1901, with seed grains, were largely a continuation of those conducted during 1899 and 1900. Drought caused all grains to ripen about 10 days earlier than in the previous season. Hungarian Brome grass was a new forage crop tested. It proved especially adapted for early spring and late fall pasture, formed a strong sod on sandy soil, and proved remarkably drought-resistant. The yield of hay was light, coarse in quality, and not eaten so readily by stock as timothy and clover. Experiments with Brome grass were to be continued and also with soy beans and cow peas.

New tests, by Prof. Moore, showed that to be entirely effective as a preventive of smut, seed oats must be submerged for 20 minutes in a solution made at the rate of 1 lb Qt. of formaldehyde (formalin) to 50 gallons of water.

Prof. Woll and R. H. Shaw continued their experiments in the culture of sugar beets, during the years 1900 and 1901, according to a plan similar to that followed in previous years and reported the results in the 18th Annual Report. They mentioned, incidentally, that Wisconsin's first beet sugar factory, at Menomonee Falls had been in successful operation for about a month, Dec. 7, 1901 and had produced 3,500 barrels of extra fine granulated sugar, from 12,000,000 lbs. of beets. The average sugar content of beets received at the factory to date had been 14.5 per cent. Prof. Woll and A. Vivian also reported the analysis they had made of licensed fertilizers during 1901.

Roscoe H. Shaw, illustrated and described a simple apparatus he had devised to facilitate the analysis of sugar beets, and gave a report of the miscellaneous chemical work he had done. In addition, over one hundred samples of milk and cream, from different parties in the state, had been tested by the department of Chemistry during the year.

Prof. Goff published in the 18th Annual Report an interesting illustrated paper regarding studies he had made of certain conditions affecting the ~~selling~~ setting of fruits. He inferred from his tests that the pollen of the apple, cherry and plum will not be discharged much during a rain storm, or while the trees are wet with rain, or enveloped in fog. A prolonged rainy period during bloom will not, however, be likely to injure the vitality of pollen, so long as the weather remains cool. A temperature of 4° F. below freezing did not prevent pollen of the plum and cherry from germinating slightly, and that of the Wallace raspberry germinated freely after having been exposed to 9 degrees below freezing. A vigorous growth in the cherry tree did not necessarily interfere with the setting of the fruit. He concluded that the failure of the pistil, in flowers of the native plum, is probably due, in the majority of cases, to a return of cold weather after the buds become activated in spring. The report also contained an illustrated summary of Prof. Goff's investigation of flower-buds, which was more fully described in the annual report of the Station for 1899.

F. Cranefield gave a third report on experiments in pinching raspberry shoots which had been originated by Prof. Goff. Drought outbreak during the season of 1900-1901 reduced the yield of fruit to not less than one-half that of the previous season. The tests indicated that high pinching, at 18 and 24 inches, increased the yield of the Gregg raspberry and decreased the yield of Cuthbert. Low pinching, at 12 inches, appeared to have decreased the yield in both cases. Pinching had increased the production of shoots of the Gregg, and decreased the production of both shoots and suckers, in the Cuthbert. The experiments were to be continued.

An experiment conducted by F. Cranefield in 1901 furnished an opportunity for a comparison of different methods of sub-irrigation, with surface water, of flower beds. He decided that water can be best and most economically supplied by sub-irrigation. A permanent water-tight basin proved more satisfactory than tile laid on an earth bottom.

Experiments described by F. Cranefield covering the germination of over 25,000 seeds led him to conclude that a formaldehyde (formalin) solution as weak as 2.5 parts to 1,000 may injure oats for seed; that the injury increased, as the strength of the solution was increased; that an increase in the length of time of immersion does not proportionately increase the injury when the standard formula (2.5 parts to 1,000) is used; and that the growth of the plants appeared to be checked at first, as a result of treating the seed; but at the end of 30 days that the plants from treated seed very nearly equaled in hight those from the untreated seed. All of the tests were conducted indoors. It was thought possible that field conditions might prove more favorable to germination and growth.

The text of the Wisconsin Fertilizer Law and of the Wisconsin Feeding Stuff Law, was printed as the concluding matter of the 18th Annual Report.

The Passing of Prof. E. S. Goff

Director Henry, in the Ninteenth Annual Report of the Experiment Station, for the fiscal year ending June 30, ~~1890,~~ 1902? announced the Prof. E. S. Goff had passed away on June 6 of that year. A brief tribute to that ~~imminent~~ eminent scientist, who, since 1889, had been horticulturist of the Wisconsin Agricultural Experiment Station, followed from the pen of Director Henry, who termed him a "cherished associate and co-worker" and said of him; "As an investigator, Prof. Goff was original and ingenious, always persistant and deeply in earnest in his undertaking. His best single work was his study, carried on at the Wisconsin Station and at the University of Chicago, on the time and manner of the formation of flower buds in fruit trees. xxx As the first horticulturist of the University of Wisconsin, Professor Goff made a success of his work and left a record which it will be hard for any successor to equal."

Emil Peter Sandsten, a native of Sweden, was appointed horticulturist to fill the vacancy made by the death of Prof. Goff. He received the degree of Bachelor of Science from St. Olaf College, in 1918, and from the University of Minnesota the Master's degree in 1924, and from Cornell University the Doctor's degree, in 1927. In July, 1901, he was elected assistant in horticulture in Maryland Agricultural College, and associate professor of horticulture in 1902. In 1913, after engaging in commercial horticultural work in Montana, he was appointed State horticulturist and professor of horticulture of the Colorado State Agricultural College at Fort Collins. He is a fellow of the Royal Horticultural Society of England.

Alfred Vivian, assistant in agricultural chemistry, resigned in August 1902 to become assistant professor of agricultural chemistry in the Ohio State University in 1915 and was appointed Dean of the Ohio College of

Agriculture. He was temporarily succeeded by John Clarence Brown, who had graduated in agriculture at the Iowa State College in 1899, and received thethe M.S. degree from that institution in 1900. At the time of this appointment he was pursuing studies in agricultural chemistry in the Wisconsin College of Agriculture, leading to the degree of Ph.D.

Professor Whitson was advanced to the position of agricultural physicist, vacated by Prof. King.

F. J. Wells, a graduate of the Oshkosh Normal School and Lawrence University was made instructor in agricultural physics after serving as principal of the De Pere Wisconsin public schools.

E. G. Hastings, who had been studying in Germany during the past year, returned and resumed his work as assistant bacteriologist of the Station.

Geo. A. Olson who had graduated from the agricultural course in the Wisconsin College of Agriculture was appointed assistant in chemistry, to aid in the analysis of licensed commercial fertilizers and feeding stuffs. He carried on that work until 1908, when he became assistant chemist of the Washington Agricultural Experiment Station, chemist 1910-12, head of the department 1912, and state chemist, 1916. Later he was agricultural director of The Gypsum Industries, Chicago, Illinois.

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At the time of the writing of the 19th Annual Report the roof of Agricultural Hall had been placed on the building, but it was not yet ready for occupation. A ~~meadow~~ macadam road was being built from Linden Drive, past the horse barn, and eastward along the lake-shore drive to the marsh bridge. All of the college buildings, excepting the horse barn, were being painted and put in good condition. Fifteen acres of woodland on the Hill Farm had been cleared and made available for crop growing. New fences had been built on the farm, and many other improvements made.

Director Henry, in his report, stated that the investigations of Doctors Babcock and Russell, in the cold curing of cheese, while originally of a purely scientific character were now leading to intensely practical results. The Canadian government had taken an active interest in the matter, and at least one cheese company in Wisconsin was building factories without curing rooms, their whole product as soon as made, to be shipped to central quarters for curing at low temperatures. An experiment was being undertaken at the Station, in conjunction with the U.S. Department of Agriculture to test, farther, the merits of the cold temperature method of ripening cheese.

During the year ending June 30, 1902, the Station published 6 Bulletins which are briefly summarized in the following paragraphs:

Dr. Russell, in Bulletin 88, of September 1901 gave dairy men a second detailed account of the dairying industry of the State, together with an illustrated wall-map.

Bulletin No. 89 of November 1901, by Prof. Woll, again presented a copy of the law regulating the sale and analysis of concentrated feeding stuffs in Wisconsin, and his Bulletin No. 90, of January 1902 was a reprint of the feeding stuff and fertilizer laws.

Prof. Moore, in Bulletin No. 91, of February 1902, made a further report on oat smut in Wisconsin, in which he gave the results of numbers of determinations made by himself and by former short course students and others, during 1901, relative to the percentage of smut in oat fields of the State. The general average, for all counties as determined by Prof. Moore was 20.0. The average per cent of smut infestation in fields examined by students, was 15.0. The lower percentage, found by students, was attributed to the fact that ~~this~~ their examination had been made ten days earlier than those of Prof. Moore.

The formaldehyde preventive treatment was described and its effects reported on in the bulletin.

In Bulletin No. 92, of April 1902, Prof. Woll and Alfred Vivian reported the results of the analyses they had made, during 1902, of licensed commercial fertilizers and concentrated feeding stuffs, and reprinted copies of the laws regulating the service.

Prof. King, with A. R. Whitson had continued the studies of the development and distribution of nitrates in cultivated soils, and gave the results in Bulletin No. 93, of May, 1902. Their Bulletin No. 85 of March, 1901, was of similar character. Elaborate tables and informative graphs, accompanied the text, which presented many interesting conclusions of a scientific character. The investigators had not finished their work on the subject but had concluded that the method of determining the nitrates present in the soil, which they had been using fails, under some conditions, to show all the nitrates present, to which cause might be attributed some of the discrepancies they had reported.

Director Henry, in the 19th Annual Report of the Station, published an account of the seventh year of tests made of whole corn compared with corn meal for fattening pigs. In 9 cases there was a saving through grinding the corn to meal, while in 3 cases, during the seven year period, there was a loss. The highest saving was 17.6 per cent and the lowest 3 per cent. The highest loss was 9 per cent, and the lowest 1 per cent.

Prof. Carlyle and T. F. McConnell, in 1901-1902 continued experiments in feeding young pigs from weaning time until slaughter, on rations of corn meal and ground pigs ?peas, to determine their comparative effect upon the growth, development and character of the carcasses of the pigs. The text was accompanied by cuts showing cross sections of pigs of different breeds fed the rations mentioned. It was most notable that there was a considerably larger development of the muscles on each side of the backbone, in the carcasses of pigs fed peas, than in those fed corn. The fat of the corn-fed pigs was soft, flabby and almost blubbery to the touch. The muscle was pale in color and apparently lacking in "tone". Tables showed the results in each phase of the experiments.

Prof. Carlyle also began experiments to determine whether purebred Razorback pigs would consume as much feed of the same kind and make as much live weight gain therefrom, as pigs having one-half Razorback and one-half Poland-China or Berkshire blood. He found that the cross-bred pigs ate appreciably larger quantities of grain than did the Razorback pigs, and made even greater gains in proportion to the feed consumed. It was noticed that the Razorback pigs were exceedingly variable in their appetites, frequently gorging themselves and then eating sparingly for several feeds, followed by another gorge. The Razorbacks required, on the average, 54 lbs. more of grain to produce 100 lbs. of gain, than did the cross-breeds.

From breeding records of 514 ewes at the Station Prof. Carylyle and T. F. McConnell concluded that the ewe's normal period of gestation ranges from 144 to 150 days, and that 146 days after service seems to be the average lambing time. Lambs dropped before the 144th, and after the 149th day of pregnancy, lack in strength and vitality at birth. Shropshire ewes were most prolific. Rams 2 or 3 years old and ewes 3 years old, until after 6 years old, are most prolific. Ewes bred early in the season of mating to a single ram, dropped a larger percentage of lambs than did those bred near the latter end of the season.

Further tests by Prof. Carlyle and T. F. McConnell in 1902 relative to the comparative value and effect upon the lambs of feeding various grains rations to pregnant ewes showed that dried brewers' grains was the cheapest grain ration, with bran, shelled corn and oats following in the order named. Any one of them, fed in conjunction with 2 1/2 lbs. of corn silage and 2 lbs. of mixed hay, per ewe, daily, was satisfactory for the ewes. A ration containing brewers' grains produced the most milk, that containing whole oats the strongest and heaviest lambs, while corn silage, with hay, was the best winter roughage for ewes.

Discoveries in Dairying

Observations by Prof. E. H. Farrington on the use of acid test for milk and cream were reported in the 19th Annual Report. Manns' Acid Test and the Farrington Alkaline Tablet Test were used. The results showed that when standard alkaline solutions are frozen and the ice is melted before the liquid is used, the strength of these solutions is not impaired for testing the acidity of milk and cream. No change of any consequence occurs until the tablet solution is a week or more old. Accurate tests may be made with a fresh tablet solution, or when the solution is less than a week old. Dry tablets keep their standard strength indefinitely. Exposure of the normal alkali solution used in the Manns', by leaving the bottle uncorked or letting it stand in the burette over night, weakened the solution and changed its standard strength. The curd and whey of milk or cream, in the same sample, will neutralize different amounts of acid, therefore, each sample must be thoroughly mixed before testing its acidity. The acidity of different samples of cream reached a maximum beyond which it did not develop even when held under favorable conditions for souring. A cream containing 25 percent of fat may reach 0.6 percent acid; but a 40 percent fat cream will not sour much beyond 0.5 percent acid.

Prof. Farrington also found, by tests, that when there was nearly 25 per cent of ice in milk that had frozen, the fat content of the frozen portion was 1.00 per cent less than that of the original milk, and the liquid poured off the milk-ice tested above one-half a per cent higher. There was no great difference when milk contained 40 to 50 per cent of ice. The results showed that the milk-ice, left in cans, contains nearly as much butter-fat as the unfrozen milk, and that the test of the liquid, poured from the ice at the creamery, will not be much higher than that of unfrozen milk.

Pasteurization of cream for butter, done by Prof. Farrington and J. H. Godfrey, showed that sweet-cream butter when one day old had almost no aroma, but a fresh, sweet cream taste, whereas pasteurized cream butter, when one day old, had a clean taste, not much aroma, but resembled raw sour-cream butter, more than that made from sweet cream. When 3 weeks old, the flavor of sweet-cream butter was decidedly strong, like that of old butter, while that of pasteurized cream, when 3 weeks old, became a trifle sour; but no other indications of age were shown until the pasteurized butter was 5 weeks old, when a slightly old taste began to be noticed. The texture was fully equal to that of butter made from raw ripened cream, its surface showing almost no brine, and appearing dry and smooth. They concluded that pasteurized cream butter holds its good qualities much longer than that made from raw cream, and that an acceptable flavor may be produced ~~it~~ in it by skillful use of starters, while the defects in body or grain, formerly noticed in pasteruized cream butter, may be overcome by using the improved methods of heating and cooling the cream.

From his experience of the difficulties in the way of drawing conclusions from experiments in butter making, when based on one judge's scores, Prof. Farrington suggested the importance of taking the opinions of a number of judges working independently; or sets of 3 judges should be obtained. Each set should make its report independently of the other, and none of them should know anything about the history of the butter scored.

In the 19th Annual Report Prof. Farrington also described and illustrated an improved cream-test bottle which he had devised. Having a longer neck, the new bottle made it possible accurately to read tests to much less than one percent of fat.

Doctors Babcock and Russell, with A. Vivian and U. S. Baer presented new facts regarding the influence of temperatures approximating 60° F. on the development of flavor in cold-cured cheese. They found that mild flavors characterizing cold-cured cheese may be intensified by subsequent exposure to approximately 60° F. Higher temperature and prolonged exposure thereto tend to develop an objectionable sharp "tang". When the desired flavor has been obtained the cheese should be returned to lower temperatures for storing and will then remain unimpaired for many months. With cheese made from first class milks, the rate of ripening can be hastened by a brief exposure to a temperature not much exceeding 60° F.; but low temperatures are preferable for the bulk of curing. With imperfect milks, there is always danger in curing, even for a brief period, at temperatures normally employed. Cold curing is preferable with such milks.

The same investigators found that the chief factors determining the formation of white specks in cheddar cheese seem to be temperature and salt. Low temperatures greatly favor the production of the specks, but they rarely appear at 60° F. unless other conditions are peculiarly favorable for their production. The addition of salt tended to prevent their formation under all conditions, while increased quantities of rennet lessened their occurrence.

They do not appear in very rich cheese, even at low temperatures; but are especially abundant in skim cheese. No specks were found in sweet-curd cheese, at any temperatures.

Coop Work in 1902

Prof. Whitson continued the four year rotation of crops begun by Prof. King viz.: Oats seeded to clover; clover; potatoes on manured clover sod; and corn. He also made observations relative to moisture required by crops. Assuming that, under Wisconsin conditions, the maximum crop of corn and potatoes can be produced with 18 inches of rain during the growing season, of oats with 12 inches, and of hay with 24 inches, tables prepared by him showed that there had been a shortage of 4 inches, or over, on 10 years, during the corn and potato season, on 12 years, during the hay season, and on 4 years, during the oat growing season. The soy bean used 527 lbs. of water per pounds of dry matter produced, or nearly twice that needed to produce a pound of corn, somewhat more than for oats, and somewhat less for clover. The averages of several determinations previously made by Prof. King, of the water used to produce a pound of dry matter were: for corn, 270.9 lbs; for oats, 503.9 lbs., and for clover, 576.6 lbs.

Prof. Whitson, with F. J. Wells and A. Vivian, also carried on field and plant house experiments with corn, oats, barley, rape and peas, to determine the influence of the soil on the protein content of such crops. Stutzer's method was followed. They found that most of our farm crops show large variations in the percent of protein, at the same stage of their development. This variation may exist even when the crops are making practically equal growth. Under similar seasonal conditions, the most important factor in causing this variation is the amount of nitrogen in the soil.

In 1902, Prof. Whitson, continued experiments with black marsh soil to compare treatment with potash fertilizers and green manuring, to determine how long the beneficial influence of potash and manure will last, the effects of different amounts of potash, and the best methods of applying potash fertilizer. The work was done in the plant house, and in the field. On the poorer class of soils, the application of potassium sulphate and of green manure more than trebled the yield. On the better soil the effect of both treatments was much less marked. The application of green manure was nearly as effective as that of potash. The influence of the fertilizers on the second crop was only a small fraction of that on the first crop. The effect of a good dressing of farmyard manure was noticeable the third season. On corn, a small amount of potash was just as effective as a larger one. With the ordinary distance of planting corn, 50 to 75 lbs. of potassium sulphate, per acre, appeared to be the most profitable amount to use. In order not to prevent germination, this should be placed from 1 to 2 inches below, and to one side of the seed in the hill.

Prof. Moore was assisted by A. J. Meyer, special agent of the Bureau of Plant Industry, Washington, D.C. in the experiments he conducted with grain and forage plants in 1902. Many varieties of grain were tested. Soy beans were also grown with corn, and for silage and some inoculation tests made. It was concluded that the plant and soil are helped by the growing of leguminous crops especially where nodules develop on the roots of such plants. Nodules developed freely where soy beans had been inoculated with water from a mixture of Michigan soy beans and mellow soil. The soil on inoculated plots became filled with bacteria which seemed to help its physical condition as well as add nitrogen for future use by plants.

Tests were also made of alfalfa, clover, brome grass, vetch, flax and sorghum, and further tests conducted in the treatment of oats against smut, as reported in Bulletin No. 91. Sand Vetch made a fine fall and early spring pasture, especially when sown with winter rye, and was considered a strong nitrogen gatherer, as its roots developed numerous nodules. Grain breeding work was begun and the grain obtained was to be held over and tested the following year by the Congener plot method

Sugar beet experiments were conducted in 1902, by Professors Woll and Moore, in cooperation with the Bureau of Chemistry, U.S. Department of Agriculture. Beet seed was not distributed for trial purposes in 1902. The investigation of the adaptability of the soil in different parts of the State for the culture of sugar beets being considered closed, after 12 years of work in that direction, conducted under supervision of the Experiment Station. On the Station farm sugar beets were produced at the rate of nearly 30 tons to the acre, in 1902, the previous average for 8 years, having been 14.14 tons per acre. The yield of sugar was correspondingly high, all conditions that year having been unusually favorable.

The 19th Annual Report also contained the usual report on the analysis of licensed fertilizers and feeding stuffs, for 1902, by Woll and Olson; a fourth report by F. Cranifield on the effect of pinching rasberry shoots; a report by him on the influence of formaldehyde on the germination of oats, and a paper on road construction by Leslie H. Adams.

CHAPTER XII

Twenty Years of Progress

The Twentieth Annual Report

When the twentieth Annual Report of the Wisconsin Experiment Station was published for the fiscal year ending June 30, 1903, the College of Agriculture had been housed in Agricultural Hall, the new central building provided for by the legislature of 1901. The legislature of 1903 had pr vided $25,000 for the equipment of the building, and this sum was being expended for that purpose. Director Henry described the building in his annual report as follows: "The structure has a frontage of 200 feet, by 64 feet in depth, and is 3 stories in height over an amply lighted, full height basement. In the rear is an addition in the form of an octagon, 2 stories in height and 66 feet across. The building is constructed of buff pressed brick, terra cotta, and Indiana buff Bedford limestone. It has a roof of red tile, and all outside metal work, including cornice, is of copper. It is of slow-burning construction throughout. Heat is supplied by the central heating plank." The arrangement of the laboratories, lecture rooms, offices, etc. was shown in accompanying floor plans. A view of the building faced the title page of the report. On the basement floor of the octagon at the rear is located the agricultural library, housing 20,000 volumes, and a commodious reading room. On the floor above is the auditorium, and a gallery communicating with the second floor. The hall has a seating capacity of over 700. For the building the legislature of 1901 appropriated $150,000. The plans were drawn and the construction supervised by J. T. W. Jennings, the university architect. Cement sidewalks had been built about the building and a macadam highway completed, leading from the top of Observatory Hill, in the rear of the Auditorium, past the building south of Linden Drive.

Extensive improvements and additions to the horticultural building were nearing completion, and two greenhouses had practically been rebuilt, and a new one added. The laboratories of the horticultural department had been greatly improved, and important changes made in the Agricultural Physics department to affort better facilities for student and research work. At the farm, during the early winter of 1902-1903, a steam-heated, sky-lighted stock building, 36 by 72 feet in area, had been erected.

The legislature had also furnished $15,000 for a building for the department of farm engineering, to be erected during 1904; and $10,000 for the purchase of purebred livestock, part of which had been expended at the time of the publication of the 20th Annual Report.

Changes in the Station Staff

In 1903, ~~G~~ I. F. McConnell, instructor in animal husbandry resigned, to accept a position at the Arizona Experiment Station, and William B. Richards, of Cambria, Wis. and a graduate in agriculture of the University of Wisconsin, was appointed instructor. Later he was made assistant professor and then professor of animal husbandry, continuing acceptably until 1914, when he was appointed agricultural field agent in North Dakota Agricultural College where he remained until 1918 when he became county agricultural agent at Ellendale, N.D. and in 1919 assumed a similar position in Kane County, Illinois.

Prof. Carlyle's duties were assumed by George Colvin Humphrey, of Palmyra, Michigan in September 1903. He had received the Bachelor of Science degree from Michigan Agricultural College, in 1901 and had done some instructional work before coming to Wisconsin. So able and energetic was his management of the department of animal husbandry that it quickly became a "power for good" in the state, and Director Henry rightly called him "a man of industry and integrity." He quickly built up a splendid reputation in the State, and organized many useful county breeders associations. Recognition also came to him from foreign countries, for he was called to judge dairy cattle at Palermo Exposition in Argentina, in 1922 and at the Territorial Exposition at Hawaii in 1924. He has likewise officiated expertly as a judge of dairy cattle at many state and county fairs. The breeding and feeding of dairy cattle has been his specialty, and he has also given much attention to other phases of animal husbandry.

Dr. A.S. Alexander who, since 1890, had been professor of veterinary hygiene, zootechnics, breeding and feeding in Chicago Veterinary College, was in 1903 appointed station veterinarian and instructor of veterinary science and horse breeding and management. During the winter sessions of 1901 and 1902 he had been lecturer and demonstrator in veterinary science to the Short Course students, and for 13 years, before coming to Wisconsin, had been in active veterinary practice at Wanye? Wayne and Evanston, Illinois. He came, originally, from Scotland, where he had obtained a scientific and practical education in veterinary science, livestock husbandry and agriculture, obtaining the certificates at the Glasgow Veterinary College, Andersonian University and Government Science and Art Department, and the Scottish National degree in agriculture (F.H.A.S.). He graduated from the Chicago Veterinary College in 1897 with the degree of Doctor of Comparative Medicine (M.D.C.). He served as Veterinary Hygienist of the World's Columbian Exposition, 1892-3; consulting Veterinarian of the St. Louis Exposition; official Veterinarian of the International Live Stock Exposition, 1900-03, and was veterinary inspector to the Milwaukee, Wisconsin, Medical Society, 1908-12. He has been a copious contributor to Veterinary, livestock and agricultural publications and is the author of several books, notably, "Udder Diseases of the Cow and Related Subjects", (1927).

The previous veterinary instructors had been: V.T. Atkinson, V.S. 1886-1891; C.A. Woodward, V.S. 1892-1893; W.G. Clark, V.S. 1894-1895; J.P. Laws, D.V.S. 1896-1897; S. Beattie, V.S. 1898-1899; and A.G. Hopkins, D.V.M. 1899-1901.

Mrs. S. M. Briggs, a graduate of the University, was appointed librarian in charge of the Agricultural College library and began work in August, 1903.

G. N. Knapp, a practical farmer from Minnesota and a graduate of the University of Wisconsin, was appointed assistant professor of farm engineering. For some time before coming to Wisconsin he had been employed by the United States Geological Survey, in New Jersey.

The legislature of 1903, having appropriated $2500 annually for two years of cranberry studies, ~~an~~ the investigation was undertaken by Professors Whitson and Sandsten, assisted by L. P. Haskins, a University student, and by Henry A. Ramsey, a graduate of the Minnesota Agricultural College. The Wisconsin State Cranberry Growers' Association had, for a number of years, been conducting a cranberry experiment station near Cranmoor, Wood County, Wis. This the Association turned over to the Wisconsin Experiment Station. It was improved by the addition of a water storage reservoir of 1 1/8 acres, and by fitting 5 acres of land below the reservoir for the growing of cranberries.

During the season of 1903, tobacco investigations were made by Professor Sandsten in Rock County and Sauk County. Various commercial fertilizers had been systematically applied on tobacco fields at several points in the state, and a limited amount of choice seed, for gratuitous distribution, had been grown on the farm of A. L. Fisher in Rock County.

The 20th Annual Report listed for the first time the following additional workers on the station staff: F. B. Fulmer, instructor in butter-making, winters of 1894-1898; V. H. Bassett, B.S., assistant bacteriologist, 1898-1899; G. Rohn, instructor in butter-making, winters of 1899-1900; Harvey Sandell, assistant in agricultural physics, Feb., 1900; DeWitt Goodrich, instructor in butter-making, winter of 1901; F.J. Wells, B.S., instructor in agricultural physics, 1902, assistant professor, 1903; G.H. Benckendorf, instructor in farm engineering, March 1902; J. F. Nicholson, M.S., assistant bacteriologist 1901-1902; J. C. Brown, M.S., assistant in agricultural chemistry, 1902; instructor, 1903; J. R. Danks, assistant in animal husbandry (Dairy cattle) 1903; James Hulton, assistant in animal husbandry (horseman), 1903; A. L. Stone, assistant in agronomy, 1903.

ADDITIONAL LAND ACQUIRED

Through the generosity of the last legislature the Experiment Station had acquired 60 acres of land adjoining the Hill Farm of 160 acres, making 220 acres of land in a solid body, to be used largely by the department of agronomy.

In 1903 the total value of land used by the College of Agriculture and the Experiment Station was $35,500 and of the buildings, $317,500 with personal property valued at $64,083.30.

The fixed income of the College of Agriculture and Experiment Station in the year 1903-1904 was $29,000 from the United States government and $52,500 from the state of Wisconsin, a total of $81,500. It was estimated that the total expenses of the Experiment Station were about $30,000 annually, aside from the sum especially appropriated for tobacco and cranberry investigations by the last legislature.

The 20th Annual Report was chiefly devoted to a brief history of the Agricultural College and Experiment Station, from the time of its establishment, written by Director Henry, and to an extensive resume of the investigations conducted at the Experiment station from 1893 to 1903. The various chapters were prepared by the department chiefs and summarized the reports and bulletins which have already been considered in this history.

During the year ending June 30, 1903, the Experiment Station issued Bulletins No. 94 to 100, inclusive. These are briefly summarized in the following paragraphs, and a synopsis of Bulletin No. 96, on investigations of methods of milking cows, also appeared in the previous annual report for 1902.

COLD - CURING OF CHEESE

Doctors Babcock and Russell, in Bulletin No. 94 of August 1902, gave the cheesemakers of the state a complete and up-to-date account of the work they had accomplished relative to the curing of cheddar cheese, with special reference to cold-curing. It was the seventh of the educational bulletins on dairying begun in Bulletin No. 60, of May 1887 and presented, first, particulars regarding other methods of cheese curing. The matters then discussed pertained to the influence of cold-curing on quality, flavor, texture, body, color and price of the cheese; uniformity of the product; subsequent development of flavor in cold-cured cheese; use of increased quantities of rennet in such cheese, and its keeping qualities. How to lessen losses in cold-curing was also explained, and particulars given as to the general application of the cold-curing system, and regarding the consolidation of cheese-curing ~~nations~~ stations. The facts presented were those which have been outlined in the summaries of previous bulletins and Annual Reports.

METHODS OF MILKING

Professor Woll, in Bulletin No. 96, of September 1902, told of investigations he had conducted with cows in the University herd and in 12 different Wisconsin dairy herds, to determine the effects of different methods of milking. The aim, in all cases, was to ascertain the gain in the yield of milk and butter fat obtained by the Hegelund system or method of manipulating of the udder, after the regular milking was finished. The method was illustrated and described. The plan of the experiments also showed the character of the work done by the different milkers. The experiments proved that the manipulations mentioned increased the daily production of milk, from 24 cows in the University herd, by 4.5 per cent, and the production of butter fat by 9.2 per cent. The experiment continued for 4 weeks. The average gain in milk was 1 lb. and in fat .09 lb. per day. In the 12 herds tested, away from the University, there was a gain of 1.08 lbs. in the daily production of milk per cow and .1 lb. of fat. The test of these cows extended over a period of 4 months, with cows in all stages of lactation, and indicated that the gain is maintained throughout the entire period of lactation. The greatest proportion of the gains obtained came through failure of the milkers to milk the cows dry. The "strippings" obtained by the manipulation process averaged, for all the herds, 10.32 per cent of butter fat. The results obtained from the investigations suggested that a thorough system of milking is a fundamental requirement of successful dairying.

Bulletin No. 97 of December 1902 by Prof. Woll and George A. Olson, gave the analyses of concentrated feeding stuffs they had made, in accordance with the provisions of the Wisconsin feeding stuff law passed by the state legislature in 1901 and in effect January 1, 1902. Twenty-three manufacturers or dealers had taken out licenses for the sale of 40 different brands of concentrated feeding stuffs in 1902.

In illustrated Bulletin No. 98 of February 1903 Professor Moore gave a further report about the prevention of oat smut and potato scab by formaldehyde solution immersion. Twenty-one experiments in oat smut prevention had been conducted by members of the Wisconsin Agricultural Experiment Association which had been organized by Prof. Moore February 22, 1901, and had a membership of 500 when Bulletin No. 98 was issued. No less than 1,000 farmers had successfully treated their seed oats during the past season.

Tests made in the oat fields of 262 farmers residing in different counties of the state had shown 17 per cent of smut present. The strength of solution advised, in which to immerse the oats for 10 minutes, was made by pouring 1 pint of 40 percent formaldehyde into 36 gallons of water: the oats afterward to be dried on a floor. Potato scab was to be prevented by submerging the uncut seed potatoes for 2 hours in solution made by mixing 1 pint of formaldehyde with 25 gallons of water.

Bulletins No. 99 and No. 100 of February 1903 and April 1903 reported the analyses of concentrated feeding stuffs and fertilizers licensed for sale in Wisconsin during 1903.

STATION GROUNDS IMPROVED 1904

Agricultural Hall having been completed and occupied, improvement of the grounds about the building was actively undertaken, and finished early in 1904. The 21st Annual Report, for the fiscal year ending June 30, 1904, announced that much planting of shrubs and seeding of lawns had been done. Cement sidewalks had been constructed about the building, and a macadam drive approach to the east ~~pretico~~ portico and a driveway up Observat~~ion~~ory hill in the rear of the Auditorium, completed. During the autumn of 1903, the University had installed a new system of water supply which afforded better fire protection. In 1904 it was extended to the Dairy barn and additional hydrants placed wherever needed. Fire fighting equipment was also installed.

During the winter of 1904 the Farmers' Course was instituted. It covered a period of two weeks, beginning February 5, 1904. The first session of the Course was attended by 170 farmers, representing 42 different counties of the state. The Wisconsin Agricultural Experiment Association had proved so useful that the legislature of 1903 voted an appropriation thereto of $1,000 and directed the publication of 5,000 copies of the Annual Report at public expense.

Secretary R. A. Moore reported a paid membership of nearly 600 in 1904.

CHANGES IN STATION STAFF

Director Henry, with sorrow, reported the death of F. J. Wells, Assistant Professor of Agricultural Physics and Assistant Physicist of the Station, which death occurred March 1, 1904. His place was taken by Charles William Stoddard, a graduate of Columbia College.

U. S. Baer, for many years an instructor in the Dairy Department, resigned December 1, 1903, to become Assistant State Dairy and Food Commissioner. He was succeeded by W. J. Carson of Kingston, Ontario, Canada, a graduate of the Ontario Agricultural College, who had served that institution for some time as a traveling dairy instructor and, later, had been instructor in milk testing and lecturer in dairy chemistry at Kingston, Ontario, dairy school.

Frederic Cranefield, instructor, and assistant in horticulture in the Experiment Station, resigned April 1, 1904 to assume the duties of Secretary of the Wisconsin State Horticultural Society. He was succeeded July 1, 1904, by Walter S. Brown, a graduate of Alfred University, New York, and later of Cornell.

W. B. Richards, instructor and assistant in animal husbandry, resigned June 3, 1904 to become Assistant Professor of Animal Husbandry in the North Dakota Agricultural College. He was succeeded by James Garfield Fuller of Waterman, Illinois who had just graduated Bachelor of Science in the Wisconsin College of Agriculture. He began work in 1904 as assistant and gradually was promoted until in 1919 he was made professor of animal husbandry. He studied agriculture in Europe in 1910 and in 1928 obtained the Masters degree in agriculture from Iowa State College. His specialties have been horse breeding and management and beef cattle and swine breeding and feeding, in which lines of work he has been eminently successful.

Henry J. Ramsey, assistant in Cranberry Investigations, completed his work with the Department of Horticulture June, 1904.

Christian Bues, of Ithaca, New York, in 1903 and 1904 was employed by the Station to carry out the provisions of the Law of 1899 for State Nursery Inspection, and Roy T. Harris acted efficiently as traveling inspector in carrying out the provisions of the Fertilizer and Feeding Stuff Laws.

During the year ending June 1904 the Experiment Station issued Bulletins Nos. 101 to 114, inclusive. The editions totalled 281,000 copies, with a total of 8,898,000 pages. Numerous newspaper bulletins on various agricultural subjects were also sent to all of the newspapers of the state and to the general agricultural press.

Notes on the bulletins of the year follow.

SHRINKAGE OF COLD - CURED CHEESE

The Station continued its educational work for the benefit of Wisconsin cheesemakers by issuing, in July 1903, Bulletin No. 101 on the shrinkage of cold-cured cheese during ripening. It was prepared by Doctors Babcock and Russell and W.S. Baer, and included reports of experiments conducted under the auspices of the U.S. Department of Agriculture. The Eastern experiments were made at the New York Agricultural Experiment Station, and the Western experiments were made under direction of the Wisconsin Station, as a suitable curing station. The commercial cold storage warehouse of the Roach and Seeber Company, Waterloo, Wisconsin, was chosen. Rooms were fitted up, and the desired temperatures secured at that place. For the tests, close-bodied, firm, long-keeping type cheese, together with cheese of sweet curd type, and of soft, open-bodied, quick-curing type, suitable for early consumption, were used. The report was made more instructive by a number of graphs and tables.

The experiments proved that cold-cured cheese shrunk much less than cheese kept under ordinary factory conditions. The temperatures employed averaged 36.8°, 46.9°, and 58.5° F. At the lowest temperature, cheese decreased in weight in 90 days from 1 to 1.4 per cent; while that cured at the intermediate and higher temperatures lost fully 3 times as much. Cheese of the firmer type lost considerably less by shrinkage than did the softer type of cheese. At ordinary temperatures the smaller the cheese, the more rapidly did it dry out. The loss diminished as the temperature was lowered, and at approximately 40° F. was practically independent of the size. This was attributed to the humidity of the curing room which, at the low temperature, was 100 per cent. By coating the cheese with melted paraffin, the losses, at 60 degrees, were reduced more than one-half. At the intermediate temperature, the saving was somewhat less and at the lowest temperature the difference was practically negligible. It was concluded that the shrinkage in the weight of cheese in a saturated atmosphere, where evaporation is presumed not to take place is not wholly due to dessication but is effected by the production of volatile products that are formed by processes inherent in the curing cheese.

THE STATION DAIRY HERD (1893-1903)

In illustrated Bulletin No. 102, of August 1903, Professors Carlyle and Woll reported the results of investigations conducted with cows in the University dairy herd, from its founding in the autumn of 1893 until May, 1903. It included the records of 38 Jersey, Guernsey, Holstein, Shorthorn and Red ~~Pollen~~ Polled cows. The investigations were made to ascertain the capacity of each cow for milk and butter fat production and to study the system of feeding necessary for a large and profitable production. The average annual milk yield, for the various cows, was found to have been 4,033.0 lbs. to 10,963.3 lbs; and of butter fat, from 183.64 lbs. to 474.73 lbs; the net profit returned by the cows was from $19.59 to $79.31.

The authors concluded that cows of the large dairy type, of the particular breed suiting the fancy of the farmer and weighing, say 1,000 lbs. or more, will, everything considered, be found the most satisfactory for the dairy farmer.

The best producing cows in the herd, during the winter periods were fed, on the average, 25.28 lbs. of dry matter, 2.05 lbs. of digestible protein, 15.22 lbs. of digestible carbohydrates and fat with a nutritive ratio of 1:74. The low-producing cows received, on the average, 21.14 lbs. of dry matter, 1.56 lbs. of digestible protein, and 12.20 lbs. of carbohydrates and fat, with a nutritive ratio of 1:7.8. Only 10 cows, out of the total number tested required more than 2 lbs. of digestible protein in their daily average winter rations, for a large and economical production. In a majority of cases, with good dairy cows, under conditions at that time present in the Northwest, it was believed by the authors that a supply of digestible protein somewhat less than 2 lbs. per day, might be found most economical.

Professor Carlyle, with the assistance of J. R. Danks and George E. Mort- ? ~~tion~~on also tested various crops for the soiling of dairy cows and reported the results in Bulletin No. 103 of September 1903. They found that whereas each cow in the University herd required about 2 acres of pasture, when no soiling is practiced, that acreage may be reduced at least one-half, when the cows are fed cut green crops. The system of soiling cows required more labor, but the profits from it might offset the extra expense.

The crops fed included full rye, hulless barley, alfalfa, red clover, peas and oats, oats, vetches and oats, dent corn, rape, sweet corn, sorghum, giant fodder corn, millet, rye and vetches, and flint corn. Thick seeding of each of these crops was advised to supply a fine quality of more edible forage.

When given no other feed, cows ate from 75 lbs. to 100 lbs. of soiling feeds per cow daily. When good pasturage is available at night, the green feed may be reduced to an average of 45 lbs. per cow, daily. It was advised that a surplus of soiling crops, rather than the exact amount needed, be grown, since any surplus remaining could, with the exception of rape, be cured and stored as excellent feed for winter use. Rape could not be recommended for general use, on account of its liability to taint milk. In the case of a majority of the crops tests, it was found that they were most palatable and satisfactory when fed at or a little before full bloom. Barley and millet proved unpalatable, and cow-peas unsuitable for Wisconsin conditions. Giant corn had too large and ~~course~~ coarse stalks to be palatable, and caused scouring when heavily fed. Peas and oats gave larger yields of forage than vetches and rye, or vetches and oats. Sorghum proved the most valuable soiling crop for Wisconsin, being better than field corn, with Evergreen sweet corn next in value.

Experiments relative to the food requirements of pigs, from birth to maturity, were continued by Prof. Carlyle in 1903, and reported on in illustrated Bulletin No. 104 of September, 1903. None of the tests reported were considered complete. It required 277 lbs. of nutrients, on the average, to produce 100 lbs. of gain with pigs, from birth to maturity; the average cost was $3.12 for each 100 lbs. of gain made. Beefmeal, fed in some of the rations tried, seemed to have a marked beneficial influence on the strength of the bones in different pigs, as shown by use of a testing machine. The rations containing a large proportion of corn seemed to have the effect of greatly weakening the bones of the pigs to which they were fed.

F. Cranefield in Bulletin No. 105 furnished valuable hints relative to the improvement of home grounds by the use of grass, shrubs, vines and flowering plants, and gave suggestions for planting them to the best advantage. The report was profusely illustrated with pictures of attractive home grounds and offered some plans for the proper laying out of lawns and gardens. In Bulletin No. 108, of January 1904, he also described the trees and shrubs to be used for shade and ornament. These were instructively illustrated and described. Lists of the deciduous trees, evergreens and shrubs tested on the Experiment Station grounds accompanied the text, the common and scientific name of each being given.

In Bulletins Nos. 106, 109 and 113 of November 1903 and January and April 1904, Prof. Woll and Geo. A. Olson published reports of the annual work done in the analysis of licensed commercial feeding stuffs and fertilizers and in each reprinted copies of the laws relating to the service.

In illustrated Bulletin No. 107 of December 1903 Prof. Woll reported the official tests of dairy cows made in 1902-1903. They were made by the Station largely in conjunction with the Holstein-Friesian Association of America Rules regarding the conduct of official tests and directions for Station representatives in making of the tests were also published.

SPRAYING FRUIT TREES

Prof. E. P. Sandsten, the new horticulturist of the Station, introduced himself to his brethren in the state by giving them an illustrated Bulletin, No. 110 of April 1904, practical and authentic facts and advice in the spraying of fruit trees together with notes on the common insects and fungus diseases infesting orchards. A feature of the bulletin was the new matter and illustrations regarding the plum curculis. Other injurious insects, fully considered, were the codling moth, Kent caterpillar, and plum gouger of the biting type, and the apple tree louse, oyster shell bark louse, San José scale and plum tree aphis, of the sucking pests. The fungus diseases discussed were apple scab, brown rot, plum pockets, black-knot, and apple blight. Information about the various insecticides and fungicides and the best methods for their application, was also furnished, the bulletin being entirely of informative character.

Professor Moore, in Bulletin No. 111 of March 1904 gave a further report on the results of extensive experiments which had been going on for the past 5 years at the Station relative to grain smut and its prevention. He estimated the losses caused in the state by oat smut during the past 3 years at $13,500,000. Where farmers had used the formaldehyde preventive treatment recommended and reported on by the Station, or secured seed oats from farmers who had used the treatment, the crop was free from smut. He had found that wet seasons check the increase in smut prevalence. This was especially true where oats lodged and subsequent rains washed the immature smut spores onto the ground. Lodging lessens the vitality of the grain which, if kept and used as seed, usually produces only a partial crop. He concluded that by the exercise of constant vigilance on the part of the farmer and seedsman smut could practically be controlled in the future.

ALFALFA GROWING

Past experience in growing alfalfa at the Experiment Station and the data obtained from over 100 ~~farmer~~ former students who had been growing alfalfa in many counties of the state enabled Prof. Moore in Bulletin No. 112 of March 1904, to publish conclusions on the subject for the instruction of farmers. He was of the opinion that alfalfa can be grown to advantage on well-drained porous soils that are never overplowed, but not on heavy clay soils or on cold bottom lands, or in late summer or fall. Fall plowing for alfalfa was advised and in all cases, the soil should be thoroughly prepared. Twenty pounds of alfalfa seed should be used per acre, along with one-half the usual amount of grain per acre used as a nurse crop. Barley was preferable to oats as a nurse crop. Very little difference was noted in the appearance of the plants or yields of hay from the different so-called varieties of alfalfa. Three or four cuttings annually of alfalfa should yield 4 to 5 tons of well-cured hay. Alfalfa was not found more difficult to cure than heavy growths of clover. In all of the alfalfa fields examined bacteria-bearing nodules developed. All farm animals and poultry ate green and cured alfalfa with relish and thrived on the feed.

The last bulletin published in the fiscal year ending June 30, 1904, was No. 114 by Dr. Russell, and presented an instructive lesson in bovine tuberculosis. It showed that tuberculosis may be widely distributed in a herd without being recognized. Its seriousness, as a menace, was enhanced by the fact that it is slow and insidious in development compared with a more rapidly acting disease. The author advised against bringing an animal into a herd, even for a short time, unless it had been proven free of the disease by application of the tuberculin test. The malady might be more quickly eradicated were purchasers to insist on application of the tuberculin test as a guarantee of health. It is so readily applied that no owner should longer ignore its use in his herd.

ANIMAL HUSBANDRY RESEARCH

In the 21st Annual Report Director Henry gave an account of his eighth year trial of whole corn compared with corn meal for fattening pigs. A summary of the previous seven years' work in that project appeared in the 20th Annual Report. The last test again showed that corn, either ground or whole, should not be used exclusively as a feed for pigs or young hogs. A positive disadvantage was found to follow the grinding of the corn to meal. Director Henry concluded: "So disastrous were the results that it is doubtful if we are warranted in continuing such experiments with hogs".

J. G. Fuller conducted an experiment for the study of the effects of feeding wide and narrow rations to young pigs. The results were given in his thesis submitted for the degree of Bachelor of Science in Agriculture, a synopsis of which appeared in the Annual Report for 1904. Pigs fed corn meal, wheat middlings and skimmed milk, made almost 3 times the gain made by those fed exclusively on corn. The corn-fed pigs failed to develop strong bones and showed evidences of ill-thrift. The others developed into ideal pigs and, when tested, their thigh bones proved 50 per cent stronger than those of the corn-fed lot.

George C. Humphrey experimented in 1904 to learn something of the value of soy beans as compared with middlings to balance a corn ration for pigs. Six purebred Improved Yorkshire pigs were divided into 2 equal lots and used in the test. Little difference was found in the pigs fed one-third soybean meal and two-thirds corn meal, and those fed one-third middlings and two-thirds corn meal; but the soybean ration seemed a trifle more favorable than that containing middlings.

In 1904 L. R. Davies submitted a thesis, on the yield and composition of sows' milk, for the degree of Bachelor of Science, University of Wisconsin. A synopsis of the thesis, written by Dr. A. S. Alexander, was printed in the 21st Annual Report of the Station and showed that the milk production of sows varies considerably according to breed, temperament and feeding, and is influenced by these factors to the same degree as with dairy cows. Suckling pigs made their chief gain in weight during the night time. Those in the experiment showed 70.89 per cent as the proportion in gain made at that time. Young pigs can be fed more economically per 100 lbs. gain in live weight than at any other time. Marked variations in temperature affect the weight of pigs favorably or unfavorably, while slight variations have no appreciable effect. The average daily yield of milk by the Berkshire sow tested was 5.56 lbs., or, as closely as could be estimated, a total yield of 389.20 lbs. for the 70 days of the trial. Analysis of the sows' milk showed water, 83.28 per cent; total solids, 16.72; fat, 5.41; solids not fat, 11.31; casein and albumen, 4.76; sugar, 5.47 and ash, 1.08.

J. G. Fuller and Frank Kleinheinz reported a test with 14 ewes to determine the daily yield and composition of their milk. Dorset ewes yielded the largest quantity of milk, viz., 4.28 lbs. per day, while the Southdowns gave the smallest quantity or a little less than 2 lbs. The average amount of fat was 7.05 per cent. Fat was lowest in Shropshire ewe milk. Only about one-half the daily yield of milk by a ewe could be obtained by hand-milking. In yield of milk the breeds stood in the following order: Dorsets, Oxfords, Montanas, Shropshires, Merinoes and Southdowns.

W. B. Richards and Frank Kleinheinz compared the feeding value of soybeans with oats, as an adjunct adjoint with corn, fed to lambs. Twenty ewe lambs, in two equal lots, were used in the test. The lambs fed oats made better gains than those fed soybeans before June grass hay was fed in place of clover hay. The difference in the protein content of the two hays did not account for the difference in gain. That was attributed to the fact that the lambs fed soybeans required more time to become accustomed to that feed. Soybeans, however, proved to be excellent for balancing the grain ration of growing lambs.

George C. Humphrey and Frank Kleinheinz continued a test begun by Prof. W. L. Carlyle, to determine whether it is best to confine fattening sheep in winter or let them run part of the time in the yard or fields for exercise.

The advantage, though not great, proved to be in favor of confinement rather than exercise. The verdict was not considered final.

W. B. Richards and Frank Kleinheinz experimented with 40 ewes, in 4 equal lots, to determine a system of feeding which would give the best results in maintaining ewes in ideal condition during pregnancy, yield the largest supply of milk at parturition, and produce a maximum crop of vigorous lambs. The trial began December 20 and ended February 21. The results showed that a grain ration of 1 part corn, 1 part oats and 1 part bran, with corn silage and hay, was most satisfactory for breeding ewes, and as economical as feeding one grain such as shelled corn, whole oats, wheat bran or dried brewers' grains. As regards milk production, brewers' grains produced better results than the mixed ration mentioned. The average increase of lambs was greater in the 4 lots fed a single grain ration, but the per cent of strong lambs was not so high. Corn silage with hay proved to be a good winter roughage ration for breeding ewes, as in all trials previously made at the Wisconsin Experiment Station.

Professor Woll and George C. Humphrey experimented with the Station dairy herd during the spring of 1904 to determine the practical value of soybean silage for milk cows, by feeding it in comparison with corn silage and corn-soybean silage. While all the cows seemed to relish the mixed silage nearly as well as the corn silage, 3 cows absolutely refused to eat the soybean silage, and nearly all the cows ate this silage apparently with less relish than the corn or mixed silage, and ate less of it than either of the other kinds of silage.

When changing from corn-soybean silage to soybean silage, it was found necessary to increase the grain allowance to a number of the cows in order to prevent a large shrinkage in production. It was made evident by the experiment that soybean silage is not as valuable a feed for milk cows as corn silage or corn-soybean silage, considering the immediate productive capacity of the feeds, and it has other disadvantages: viz.: a lower yield of feed substances obtained from an acre of soybeans than from an acre of corn; the rank odor of the soybean silage is most unpleasant to both man and beast, and the fact that it taints milk, butter and cheese. The experimenters, therefore, concluded that a satisfactory grade of milk or other dairy products cannot be made when soybean silage is fed to cows. The objections to soybean silage do not, however, apply to mixed corn-soybean silage, which was pronounced an improvement on corn silage, in so far as it furnishes a succulent, palatable feed, containing a somewhat larger proportion of nitrogenous food material than is found in pure corn silage. It was added that ewes objected at first to soybean silage, but took kindly to it afterward and apparently improved in condition the following two weeks while it was being fed.

Theses submitted by W. B. Richards and E. L. Jordan in 1903 and 1904, respectively, for the degree of Bachelor of Science in Agriculture, University of Wisconsin, reported experiments on the effect of different stable temperatures upon the milk yield of dairy cows. A summary of the papers, written by W. B. Richards, was printed in the 21st Annual Report of the Experiment Station. From the results of the 4 trials made by both parties, 3 trials showed a greater milk yield during the high temperature periods (55° F.). In the first trial the increase was 78.8 lbs., durihg the second 117.0 lbs., while the other trial showed only 3.5 lbs. in favor of the high temperature period and the amount of fat produced in the latter trial showed an increase of 1.08 lbs. in favor of the low temperature period (44° F.). The remaining trial showed the milk yield to have been 88.85 lbs. in favor of the low temperature period. Very little difference was noted in the amount of feed consumed by the cows during the warm and cold periods.

A synopsis by Dr. A. S. Alexander, of a thesis submitted by F. H. Knobel for the B.S. degree in 1904 on the causes of variation in the weight of dairy cows, appeared in the 21st Annual Report. The investigation showed that the live weight of a dairy cow does vary; that the latitude of variation in dairy cows is within the limits of 30 1/3 lbs. A single cow varied, on an average, 16.5 lbs. per day. The greatest variation in normal was in the direction below the average weight. The causes of variation were: variation in the amount of water drunk; liquid excrement; solid excrements; milk ~~main~~flow, and food transformed to heat, etc.

Work in Dairy Bacteriology Tests made by Dr. Russell and E. G. Hastings in 1903-4, to determine the relation in flavor development in cold-cured cheese to bacterial life in the same, were reported in the 21st Annual Report. They made a bacteriological study of a number of cheeses which had been ripened in cold storage for varying periods of time, then divided into two parts, one of which was restored to the original ripening room at 40° F. While the remaining part was placed at 60° F. After 39 days the cheese kept at 4o° F. showed a germ content of 39,568,000. Fifty-three days later an examination showed 41,068,000 and 30,356,000 in two samples. At the end of 39 days, the cheese at 60°F. had begun to deteriorate, being slightly "off" in flavor, and a little salvy in texture. The cold-stored cheese at that time showed a clean flavor and perfect texture, as it also did nearly two months later. At the end of a 6-day period, a control lot of cheese stored at 40°F. showed a germ content of 19,378,000, and at the end of 81 days, 4,004,000. At that time the flavor was still mild and clean, while with the duplicate cheese at 60°F., the flavor was very high and the taste biting. These findings were corroborated by similar tests of cheese from an entirely different source and of somewhat similar age.

The investigators concluded that it would appear more probable to consider that the immediate factors concerned in flavor production are likely to belong to certain chemical compounds of an unstable character that are liable to render chemical transformations with an increase in temperature, and that the real substances capable of producing desirable flavors are easily affected decomposition products. The exciting agents productive of complex chemical transformations may be bacteria, but it is possible, too, that soluble enzymes may also function as fermentative agents in producing the proper and essential flavor-producing compounds.

Dr. Russell and E. G. Hastings also made several trials with a number of different organisms, relative to the disappearance of bacteria artificially introduced into cows' udders. In all cases the number of introduced organisms, recovered in cultures from the udder, was less and less as the period of exposure in the udder increased; but in most cases, the milk became more or less abnormal, indicating a temporary type of garget. The effects of Bacillus prodigiosus, introduced in the udder, persisted for several weeks. The action of the introduced organisms was markedly different from that observed in the milk first drawn from the udder. The results seemed to indicate that the high germ content of the fore-milk is not attributable to the direct growth of forms in the udder itself, but more likely is due, in large measure, to infection of the milk duct and possibly the external opening of the teat.

Bacteriologist E. G. Hastings described in the 21st Annual Report a graphic method of demonstrating the action of acid-producing bacteria on casein. Professors Van Slyke and Hart of the New York Experiment Station had shown, by chemical methods, that other than liquifying organisms exert a solvent effect on the casein of milk, either directly or indirectly. They proved conclusively that compounds are formed between the casein or paracasein and the lactic acid produced from the milk sugar by bacteria. When small amounts of acid are produced, the unsaturated acid paracasein is formed. This formation is to be considered as the first step in the ripening of cheddar cheese. The Hastings report presented a plate showing in a graphical manner, the reactions of acid and casein under the influence of lactic acid bacteria and was accompanied by a detailed description of the methods used for reaction production.

The paper just mentioned was followed by one on the infectiousness of milk from tuberculous cows, by Dr. Russell and E.G. Hastings. It reported preliminary work on the problem and the facts obtained were too meager to permit of definite conclusions. It was advised, however, that not only should one consider the actual percentage of animals involved in a herd, but regard reacting cows as especially dangerous. for the reason that at any time they may pass from a state of comparative innocuousness to one of positive infectiousness, without betraying any outward sign of the disease. It was, therefore, advised that all milk from reacting cows should be considered as possibly dangerous and to be handled accordingly. By the application of heat at temperatures of about 140° F. for a period of 15 minutes, or by a briefer exposure at a higher temperature, the vitality of the tuberculosis organism could readily be destroyed.

In a second paper, which followed, the same investigators reported the results of a series of tests to determine the effect of short periods of exposure of heat on tubercle bacilli in milk. They found that the virulent tubercle organism used was killed by the application of heat at the temperature of 160° F., when exposed in sealed containers. They concluded that a temperature of 160° F. or above, for a period of one minute, suffices to destroy the virulence or the tubercle cultures, so that the disease is not produced in experimental animals, like guinea pigs, inoculated with cultures ranging from 2 to 5 milligrams.

SOIL STUDIES

Professor Whitson and C. W. Stoddard, from a series of tests relative to the influence of the soil on the protein composition of crops, concluded that the relative amount of protein in the plant is subject to very marked variations, dependent on the conditions under which it is grown. They found that the fertility of the soil is undoubtedly one of the important conditions, in respect to nitrates especially, and, also, in all probability, in respect to availability of the other essential elements. From their determinations made on sorghum in the field it also appeared likely that closeness of planting is an important factor. The more space the plant had in which to develop, the greater would be the ratio of leaves to stalks, and hence the greater the amount of protein it would contain.

The same investigators also reported on continued studies of muck and peat soils. They concluded that the black marsh soils are fertile except in areas where they require potash. The peat soils, especially, where underlaid by sand, require both potash and phosphoric acid or an application of manure to make them productive. Their most recent experiments did not indicate that the use of lime on peat soils, underlaid with sand, is especially beneficial. On account of the large amount of nitrogen they contain, the marsh soils of Wisconsin are best adapted to the production of corn, rape and the hay grasses. The danger of injury from frost, however, lessens somewhat their adaptability to corn. Such injury can be greatly lessened by drainage.

Investigators Whitson, Sandsten, Hoskins and Ramsey presented a preliminary illustrated report on cranberry investigations, conducted in 1903-4, with funds provided by the legislature. In it they outlined the conditions required for cranberry growing, nature of the desirable soil, water supply, drainage, protection from frost, weeds and methods of dealing with them, diseases, varieties and harvesting and keeping. The method of laying out, preparing and sanding cranberry bogs was to be described in a special bulletin.

Prof. Sandsten offered a preliminary report on the tobacco investgations he had made with funds specially appropriated by the legislature. Experiments with fertilizers were described and information given regarding cover crops and the growing of Sumatra tobacco under cover. Illustrations accompanied the text.

He also presented an illustrated paper on cover crops for orchards. The plants used were oats, hairy vetch, rape and blue grass. Oats gave excellent protection, while blue grass gave a negative result. Use of hairy vetch was recommended. Oats gave better protection than rye. Oats should be sown not later than August the tenth, in order to grow a considerable height before being killed by frost. The experiments conducted led Prof. Sandsten to conclude that, by use of cover crops a large share of the winter killing of fruit trees could be prevented. The cover crops would also improve the soil conditions in the orchard and add fertility to the soil.

HORTICULTURAL NOTES

Prof. Sandsten made tests during the winter of 1903-1904, following similar tests the previous winter, relative to the evaporation of water from apple trees: at the close of the first winter the difference in weight was approximately 5 lbs. per tree, between the first and the last weighing, showing that the total amount of water that evaporated was 15 to 20 per cent of the total weight of the trees. The results obtained during the winter of 1903-1904 were less striking as the weather often was moist and cloudy. The common belief that low temperature is the chief cause of the winter killing of trees, was not borne out by Prof. Sandsten's experience and observation. Low temperature is not necessarily fatal to fruit trees, provided the rainfall and the humidity are sufficiently great. The condition of the trees and the amount of moisture in the soil in the autumn, have much to do with the question.

C. A. Vallejo contributed a paper on the forcing of beans in the greenhouse as a thosis submitted for the degree of B. S. in agriculture. It was edited by Walter S. Brown and advised that beans should be planted in hills or in rows or drills, so that the plants are from 20 to 36 inches from each other. They need direct sunshine to produce their best crop and a temperature of about 50° to 60° F. at night and 70° to 75° F. in the day time. Moist soil and atmosphere are imperative. Fertilization with nitrates, phosphates and potash induces a maximum crop. Ne Plus Ultra was found the most productive variety, and of better quality than the Golden Eyed Wax beans. Fumigation with tobacco smoke proved injurious. Moist atmosphere checked red spider and <u>Aleurodes</u> <u>vaporium</u> which generally are troublesome in forced beans.

Christian Bues, with Prof. Sandsten, submitted his Annual Report of Nursery Suspection for the detection of San José scale and other injurious insects and fungus diseases in 1904. Twenty-nine nurseries were examined. The San José scale was not found in any nursery. Advice was given relative to the strawberry root louse, strawberry leaf roller, rose chafer and insects infesting apple trees and shade trees, crown gall, the twig form of the plum pocket disease, the raspberry cane-blight and asparagus rust. A supplementary list of economic insects followed.

H. J. Ramsey presented some observations on the Botrytis Rot and Drop of lettuce. Illustrations of the spores accompanied the text. The burning of sulphur to kill the Botrytis spores was not very successful. The fungus in the soil was not killed, and new spores soon formed. Complete sterilization of the soil or at least of a layer 3 inches deep, was suggested as one of the most efficient methods of preventing Drop disease of lettuce.

CROP GROWING TESTS

In 1904 Professor Moore and A. L. Stone continued the variety tests of oats, barley, rye, wheat, peas, corn, soybeans, clover, alfalfa, etc. Swedish Select oats (Wisconsin No. 4) proved most satisfactory, and Oderbrucker barley especially promising for malt making. Perkuss and Schlansted rye had given good returns when previously tested and again promised well for the future. A yellow variety of pea, originally obtained from the Minnesota Experiment Station, again gave good returns. Of soybeans, U.S. No. 9407 and the Early Brown variety proved particularly high in nitrogen content and were recommended as profitable producers and an excellent feed for farm animals. Three varieties of alfalfa were tested in 1903-1904, viz.: Turkestan, American and Sand Lucern. The hay yielded per acre from these varieties did not differ widely. American yielded 5.7., Turkestan, 5.0 and Sand Lucern, 5.6 tons per acre in all cuttings. Experiments in the growing of Iowa Silver King (Wis. No. 7), and Minnesota No. 13 (Wis. No. 8) were conducted with members of the Wisconsin Experiment Station Association cooperating in various sections of the state, with satisfactory results.

Prof. Moore also reported tests relative to the prevention of smut in oats and barley and Woll, Moore and Stone reported the results of trials with sugar beets in 1904. Remarkably high yields per acre of both beets and sugar were obtained during the season. During the past 3 years the yields obtained on the Experiment Station farm exceeded 25 tons to the acre, and the yields of sugar exceeded 3 tons to the acre.

The 21st Annual Report also contained a description of the laboratories of the chemical department by Prof. Woll and of the bacteriological department by Dr. Russell. Many fine illustrations accompanied the descriptions.

Chapter XIII.

Experiment Station Work in 1905 and 1906.

THE EXPERIMENT STATION IN 1905

No important building operations were mentioned in the 22nd Annual Report for the fiscal year ending June 30, 1905. Construction of the Agricultural Engineering Building had been delayed. Extensive improvements in grounds, roads and walks had been made. The farm lawn had been extended eastward to connect with that in front of Agricultural Hall, making a wide and beautiful stretch of sward and shrubbery nearly half a mile in length. A macadam drive was being completed, extending from Linden Drive in a northerly direction, past the Dairy Building and Director's house, to the Lake Shore Drive, and accompanied by a cement sidewalk. A new roadway for milk wagons, forming a loop behind the Dairy Building, had been put in. The sixty-acre addition to the Hill Farm had been neatly and substantially fenced. A creamery disposal plant had been constructed north of the Dairy Building, and several systems of sewage disposal were then under trial.

A Department of Agricultural Engineering having been created, it assumed a part of the duties of the Department of Agricultural Physics in charge of Prof. Whitson, and he continued his work, the title of his Department being changed to that of "Soils".

To better foster the horse breeding interests of the state, the Regents had created a Department of Horse Breeding, with Dr. A. S. Alexander as Director. The chief function of the new department was to enforce the provisions of the stallion licensing law, written by Dr. Alexander, and passed by the legislature April 22, 1905, and in force from and after January 1, 1906. A copy of the law (Chapter 116, Laws of 1905) was printed in the 22nd Annual Report. It was the first law of the kind enacted, and, in time, was adopted with certain modifications in some 26 other states, Canada, New Zealand, Scotland and some other countries.

To obtain a license for public service the owner was required to certify the animal free from hereditary and communicable diseases and submit the breeding papers or pedigree certificate of the horse for examination. The license granted designated the stallion "Pure-Bred"or "Grade", according to his breeding, and a printed copy of the license certificate had to be conspicuously posted at the home stable of the horse and at every other place where he was used for public service.

The result of enforcement of the law was quickly to retire unsound stallions, expose fraudulent pedigree certificates and properly "label" each stallion, according to his exact breeding for the information of owners of mares. It soon gave sound, pure-bred, registered stallions proper and deserved recognition and patronage, and eventually put unsound, grade and scrub stallions out of business to the material benefit of the horse-breeding industry.

STATION STAFF CHANGES

Daniel Henry Otis was appointed Assistant to Dean and Director Henry, and assistant professor of animal nutrition. A native of Kansas and reared on a farm in that state, he had obtained his B. S. Degree in 1892 and M. S. degree in 1897 from the Kansas State Agricultural College. Then he was assistant agriculturist in that institution from 1892 to 1896; assistant in dairying 1896-9; professor of dairy husbandry, 1899-1902, and professor of animal husbandry 1902-3. He managed the Deming Ranch at Oswego, Kansas from 1903 to 1905, then assumed his duties at the Wisconsin Experiment Station. There he was assistant to the Dean and Director and Assistant and associate professor of animal nutrition, 1905-9; professor of farm management, 1909-11; assistant dean, 1911-23. Since the latter date he has been Director of the Banker-Farmer Exchange, Madison, Wis., which position he still fills acceptably at the time of this writing, (1933). He has served as president of the American Farm Managers' Association;

secretary-treasurer of the American Society of Animal Production, and was a Y.M.C.A. secretary in France during the World War, and there was in charge of the farm management work of the Army Educational ~~Coeps~~ Corps. He is the author of "Farm Accounts Simplified", 1915, and of "Household Accounts Simplified", 1916 and was dairy editor of the Kansas Farmer for 4 years. ~~There~~ while at the Kansas and Wisconsin Stations he did much research work on farm management, and relative to the effect on farm profits of the size of the farm, the kinds of investments, diversity of farm production and the quality of farm products.

James Garfield Moore was appointed instructor in Horticulture in 1905. He obtained his first practical knowledge of that science on his father's farm near Shepherd, Michigan and later studied at Michigan State College where he earned the Bachelor of Science degree in 1903, the Master's degree in 1905, and the M. Horticulture degree in 1909. Serving as instructor at the University of Wisconsin until 1907, he was that year made assistant professor, then associate professor in 1910 and professor of horticulture in 1916, which position he still holds. As chief of the horticultural department he has made apple culture a specialty and has rendered eminent service in other branches of research and teaching. With Dr. L. R. Jones he revised Prof. Goff's "Principles of Plant Culture" in 1916.

Another new appointee was Edward Richard Jones, who was made drainage specialist on the staff of the Soils Department under Prof. Whitson. He was reared on a farm near Bangor, Wisconsin, and had received the Bachelor of Science degree in agriculture from the University of Wisconsin in 1905 and in 1908 took the Master's Degree. He worked with marked success as a drainage expert until 1918 when he was appointed professor of agricultural engineering and chief of that department in the Wisconsin College of Agriculture. In 1911 he had traveled in Europe to broaden his knowledge of soils and agricultural engineering.

His enthusiasm and industry quickly marked him a power in his specialties and an inspiration to his students.

G. H. Benkendorf, who for some time had been assistant in Dairying, was reappointed to an advanced position on the staff of that Department. W. J. Carson, B.S.A., Instructor in Dairying, resigned at the close of the year to accept an important position in Manitoba, Canada.

During the year Prof. Farrington, head of the Dairy Department, had devoted a large part of his time to the preparing, installation and care of the dairy exhibit, national and state, at the Louisiana Purchase Exposition, St. Louis, Mo. Three grand prizes rewarded the effort of the Department.

During the winter and spring of 1904-5 the Station force took charge of the Wisconsin Dairy, Seed and Soil special train, run by the Burlington Railroad Company over every mile of its lines, and gave educational lectures and demonstrations at many points, which ~~provided~~ proved of material benefit to farmers.

For the year closing 1904-5 the total attendance of students was 781 in all of the courses offered by the Wisconsin College of Agriculture. During the year ending June 30, 1905, the Experiment Station issued 11 bulletins, Nos. 115 to 126 inclusive, and a second edition of Bulletin No. 105. The latter bulletin and bulletins Nos. 118, 120 and 122 pertained to the analysis of licensed commercial feeding stuffs and fertilizers. During the year 14,997,000 pages of printed matter embraced in the 22nd Annual Report and bulletins were distributed from the Station, nearly all going to the farmers of Wisconsin.

Notes on the chief of the bulletins ennumerated, follow:

Effect of Forage on Quality of Cheese

Prior to their resignations U. S. Baer and Prof. Carlyle prepared an illustrated report on experiments made by them to determine the effect on the quality of cheese made from the milk of dairy cows fed on rape and other forage plants.

It was published as Bulletin No. 115 in September, 1904. They found that rape, fed in even limited quantities to dairy cows, is likely to impart to the milk a taint that is also imparted to the cheese made from it. This taint cannot be eliminated. Such cheese had both an offensive odor and taste. The objectionable flavor lessened as the period of feeding rape extended. The objectionable flavor was much less apparent when the rape was fed after milking. The body, texture and color of cheese were not injuriously affected by rape feeding. Cabbage fed to milk cows always imparted a disagreeable flavor to the milk and the cheese made from it. The objectionable flaver was intensified as ripening of the cheese advanced. Milk from cows fed exclusively upon green clover produced cheese having a low, flat flavor which finally became sharp and pungent. Green forage corn had no such ill-effect. Cheese made from the milk of cows fed on it was of fine texture, with a clean, high flavor at all stages of ripening.

Relation of Food to Milk and Fat Production

Professor Woll, in Bulletin No. 116, of November 1904, presented an essay of some 75 pages on the relation of food to the production of milk and butter fat by dairy cows. In it he gave synopses of the research work done by other scientists on that subject, and reported the results of his own experiments with the Station herd. Tables and explanatory graphs accompanied the text. He concluded that economic production of milk and butter fat by dairy cows, as regards food consumption, is dependent on numerous factors, chief of which is the cow's capacity for converting quantities of food materials into milk without gaining in her body weight. Other factors are the stage of the lactation period, age of the cow, amount of feed eaten, and the succulence and nutritive ratio of the rations. The amount of nutrients consumed in excess of maintenance requirements, per 100 lbs. of milk, ranges in different cows, at least, between 26.8 and 80.2

lbs. of dry matter, and, per pound of butter fat, between 6.8 and 18.6 lbs. of dry matter. He had found the amount of net digestible protein consumed, to range from 3.16 to 9.07 lbs. per 100 lbs. of milk produced, and from .76 to 1.70 lbs. per pound of butter fat. Good dairy cows are able to produce a unit of milk or butter fat from a smaller amount of dry matter than cows of less pronounced dairy capacity. Production of rich milk requires a larger supply of food constituents than is required to produce poor milk. For every per cent of increase in the fat content of milk, an increase of about 8 lbs. of net dry matter is required per 100 lbs. of milk produced, and the amount of net digestible protein increases about .8 lb. There is a slight decrease in the amount of nutrients consumed per unit of fat produced, with an increasing fat content of the milk, or about .6 lb. of net dry matter and .08 lb. of protein for each per cent of fat in the milk.

Toward the close of the lactation period, the amount of food materials required for the production of a unit of milk or butter fat is nearly 3 times as large as at the beginning of the period. Heifers require a larger proportion of nutrients for the production of a unit of milk or butter fat, than do older cows. Efficiency in production, for the food consumed, is at its height when cows are about 7 years old. The food of the dairy cows influences the quality of the milk produced to the extent of causing a cow to yield the maximum flow of milk of the highest fat content possible for her, when she is fed rations relatively rich in nitrogenous substances. In the North Central states, under ordinary conditions pertaining there, it will not, as a rule, be advantageous to feed rations containing over 2 lbs. of digestible protein a day, and a nutritive ratio narrower than 1:6-7 to cows of average dairy capacity.

In Bulletin No. 117 of December 1904, Prof. Woll further discussed the relation of food to dairy production. In it he offered a resumé of information previously presented. Incidentally, he mentioned that during the past winter period the cows of the Experiment Station had been fed rations containing from 1.31 to 3.55 lbs. of digestible protein, having a nutritive ratio of 1:4.8 to 8.4.

Cranberry Investigations

In Bulletin No. 119 of February 1905 Professors Whitson and Sandsten, with L. P. Hoskins and H. Ramsey, gave a detailed and well-illustrated report on their investigations regarding the production of cranberries for the market. It furnished full information about the soils and fertilizers suitable for the crop; irrigation, drainage and sanding, as a means of protection from frost; character, storage and management of the water supply; time of planting and preparation of the ground; harvesting; storage and keeping; varieties; fungus diseases; cranberry insects; and weeds injurious to the crop. Many of the illustrations of weeds were original. Another interesting illustration was that of a cranberry planting machine devised by A. L. Haskins. With this machine the vines scattered over the bog were cut into short lengths and the pieces planted in rows to any desired depth and rolled in with a flange wheel. The new machine had proved practical and was expected to become popular with cranberry growers.

In Bulletin No. 121 Prof. R. A. Moore, A. L. Stone and George A. Olson gave a resumé of the work done to date in the growing of alfalfa or lucern in Wisconsin, and the results of tests made by members of the Wisconsin Experiment Station during 1904-5. On the Experiment Station farm the American variety of alfalfa had equalled in every respect the so-called Turkestan variety and was less expensive and free from noxious weeds. European wild mustard abounded and all plots of Turkestan alfalfa sown by members of the Experiment Association ~~also did~~. Hay caps had been found essential in curing heavy crops of alfalfa, especially the first ~~crop~~ cutting. All farm animals relished and thrived well on cut green alfalfa and alfalfa hay. The investigators concluded that alfalfa has "about the same feeding value as wheat bran, and may be considered as an equal to that feed for dairy cattle and other farm animals".

Sugar Beet Production

Bulletin No. 123 by Prof. Woll was published in response to many requests for information on the subject of sugar beet culture and the condition of the Wisconsin beet sugar industry existing at that time (April, 1905). The report showed pictures of some of the beet sugar factories then in operation, and of some of the machinery employed in the production of beet sugar, and a synopsis of other facts presented in the 21st Annual Report. It also showed sample copies of the contract forms used by the factories in their agreements with growers of sugar beets.

Tobacco Growing

In Bulletin No. 124 of April 1905, Prof. Sandsten gave an exhaustive and well-illustrated report on the Experiment Station investigations relative to tobacco growing in Wisconsin, in 1903 and 1904. It was estimated that the value of the tobacco crop, annually, in the state was over $4,000,000. The tobacco produced is chiefly a fine grade for use as binders. The expense of the work done was defrayed by an appropriation of $3,000 for two years, made by the legislature. The bulletin gave needed information about improvement of tobacco seeds, fertilization of Sumatra tobacco under cover, and fermentation.

G. N. Knapp, agricultural engineer of the Experiment Station, presented in Bulletin No. 125 of April 1905, an illustrated, instructive essay of 89 pages on silo construction. Plans and details of various types of silos were given, together with advice regarding the proper handling of silage, which was deemed of vital importance.

Campaign Against Tuberculosis

Dr. Russell, continuing his campaign of education and practice against tuberculosis of cattle, offered in Bulletin No. 126 of June 1905, a convincing story of two ways of treating the disease in herds. The first described the wrong way, as demonstrated in a herd, the milk of which was used for a city supply and in another herd which had shown the most widespread development of tuberculosis recorded in Wisconsin up to that time. The second part of the paper, in a concise manner, clearly defined the correct policy to be followed in dealing with the disease. In the "let-alone policy" where nothing had been done to stay the ravages of the disease in a herd, application of the tuberculin test disclosed the fact that 57 animals out of 70 were tuberculous, and in a second herd that 69 out of 72 head had contracted the disease. Early application of the test might have saved the owners of these herds thousands of dollars. Another owner who had followed the correct policy and at once applied the test when its importance appealed to him, found but one cow affected, eliminated the animal, and so prevented spread of the infection. The writers correctly remarked "His herd was saved in the nick of time".

Animal Nutrition Work

The 22nd Annual Report, like so many of the previous ones, began its account of research work done at the Experiment Station, with a summary of the results obtained by Director Henry in his ninth year of feeding whole corn to pigs, in comparison with cornmeal. He found that pigs fed shelled corn required 30.6 lbs. more grain for each 100 lbs. of gain, than the pigs fed corn meal. The saving from grinding amounted to 5.7 per cent; but when corn is worth only 25 cents per bushel, the saving from grinding would amount to only 1.4 cents, or not enough to pay for the grinding, unless cheap power is available. With corn worth 75 cents per bushel, the saving from grinding would amount to a little over 4 cents per bushel.

In 1904-5 Prof. Humphrey made a second trial of the feeding of soybeans versus wheat middlings, as a supplement to corn meal for growing and fattening pigs. He found soybeans a little over 10 per cent more valuable than wheat middlings for economical pork production, but for firmness, fine grain and texture of flesh and even distribution of fat and lean, a ration of wheat middlings and corn meal was superior to one of soybeans and corn meal.

James A. Fuller, recognizing that the results of feeding cotton seed meal to swine had always proved more or less unsatisfactory, conducted a test to determine whether souring the meal before feeding would make it less injurious. The results obtained showed that, fed in small amounts, such as one-tenth of the grain ration, cotton seed meal did not injure pigs. It may prove fatal to them, however, when fed even in relatively small quantities. Soured cotton-seed meal was no improvement over the fresh meal for pig feed. Several of the pigs fed cotton seed meal died during the test or a few days after that feed was withheld.

The same investigator fed middlings and ground barley in comparison with corn meal as a grain ration for young sows. The experiment continued for a period of 15 weeks. The two lots fed the ration mentioned consumed nearly the same amount of feed and, with one exception, were in excellent condition at the close of the trial: one pig fed equal parts of wheat middlings and corn meal, with skim milk, lost rapidly in weight toward the end of the test. The pigs fed barley, as a part of their ration, ate a total of 3,370 lbs. of feed and drank 4,008 lbs. of skim milk with a total gain of 643 lbs.; compared with a gain of 730 lbs. made by the pigs on wheat middlings, corn meal and skim milk. The latter lot ate 3.342 lbs. of feed and took 4.608 lbs. of skimmed milk.

Prof. Humphrey and Frank Kleinheinz experimented in the production of winter lambs. On July 15, 1904, 6 ewes were bred to a purebred Dorset ram. The lambs were dropped from Dec. 23, 1904 to Jan. 18, 1905, and were strong at birth, the ewes having been generously fed and warmly sheltered. Both ewes and lambs were fully fed. All of the lambs were saved, developed good form and quality, and brought a good price. Dorset ewes were recommended for winter lamb production, as they breed early, are prolific and produce a large quantity of milk that is rich in fat. The lambs in the test averaged 60.4 lbs. when sold in Madison, and 55.4 lbs. when marketed in Chicago. The average net profit returned per head on 7 lambs sold was $6.43.

Prof. Humphrey and Frank Kleinheinz reported the results of three trials relative exercise versus confinement for young wethers during the winter season. They gave it as their opinion from these tests, that, for feeding growing wethers, close confinement in pens which are dry, well-ventilated and light, is equal to, if not somewhat better than, allowing plenty of exercise.

Prof. Humphrey and Frank Kleinheinz continued a trial, like that conducted by W. B. Richards and Kleinheinz in the winter of 1903-4 relative to the value of soybeans in grain rations for lambs. The results of the two trials showed that soybeans are an economical supplement to corn for gains with sheep, both in body weight and wool production. The increase in wool production of the sheep fed was 13.8 lbs., which sold for 30 cents per pound, increasing the profits $4.14.

Professors Humphrey and Woll presented, in the 22nd Annual Report, a continuation of the account ~~of grain~~ given in the report of the previous year, relative to the management, feeding and production of the cows constituting the Station dairy herd. It gave illustrations of the various cows composing the herd and their individual records. It was advised that a nutritive ratio narrower than 1:6.0 is advantageous only in the case of high producers. In a majority of cases, the nutritive ratio for cows in full flow of milk may profitably range between 1:6.0 and 1:7.0. The dry matter of the ration may range from 20 to 24 lbs., about 60 per cent of which may be furnished in the form of roughage. The digestible protein may range from 2 to 2.4 lbs. per head per day.

Professors Woll and Humphrey conducted an experiment during the season of 1904-5 in the feeding of dried beet pulp and molasses beet pulp to dairy cows. The results were that no appreciable difference in the nutritive effect of dried beet pulp and of wheat bran was discovered, when the bran was replaced by dried beet pulp in the proportion of 3:2 by weight in the ration for dairy cows. Molasses beet pulp produced about 12 per cent more milk and 8 per cent more butter fat than wheat bran, when replacing that feed in the proportion of 3:2 by weight. The average fat content of the milk produced when either dried beet pulp or molasses beet pulp was made a part of the ration was decreased a little more than a tenth of one per cent. When wheat bran can be bought at $18.00 a ton dried beet pulp could not be considered worth over $12.00 a ton, and molasses beet pulp not over $13.00 a ton, judging from the results of the Station experiment.

Professors Woll and Humphrey found by tests made in 1905 that the operation of dehorning dairy cows caused an average loss of about 8 per cent in the milk yield and 2 per cent in solids not fat for the first few days. An increase of about .27 per cent of butter fat in the milk resulted from the dehorning operation. The injection of tuberculin and the handling of the cows in tuberculin tests, did not cause any perceptible change in the milk secretion, when observed by these investigators.

1904-05?

In the 22nd Annual Report Dr. S. M. Babcock reported, with the assistance of J. G. Fuller, three tests on the effect of adding salt to the ration of dairy cows. The tests proved beyond question that in Wisconsin and in other regions similarly located, salt in addition to that in the feed is absolutely essential to the continued health of the dairy cow, while she is producing milk. The amount of salt necessary varies greatly in different localities, it being more at high elevations and at places remote from the sea. In general, a cow requires about .6 ounce of salt for each 20 lbs. of milk yielded. A slight excess would do no harm, and Dr. Babcock recommended that dairy cows in Wisconsin be given at least 1 ounce of salt per cow daily.

Prof. Farrington described and illustrated, in the 22nd Annual Report, a practical method of cleaning a number of Babcock test bottles at one time. Several of his test bottle washers were in use at that time in the Wisconsin Dairy school creamery, where at least 140 composite samples of milk and cream are tested each week. The butter and cheese makers using the device had found it a great ti
it a great time-saver and an easy means of cleansing the bottles. He also described and illustrated an alkaline tablet solution measuring bottle, to be used for testing the acidity of milk and cream. In this connection, it was stated that the acidity of cream does not often reach one per cent and is usually below six-tenths of one per cent. Cream is generally churned when about five-tenths of one per cent of acid has developed. This is influenced somewhat by the richness of the cream.

Prof. Farrington also presented facts regarding estimation of the amount of water in butter by the overrun obtained in each churning and reported in a thesis submitted for the degree of Bachelor of Science in Agriculture, University of Wisconsin, 1905, by Otto Uehling and Allgot Wallin. They found that working the butter immediately after washing slightly increases the water content over that obtained when the granular butter has drained for about an hour before working. Letting the granular butter stand in water for some-time also increases the water content. Increasing the amount of churning in the wash water or using warm wash water does not always increase the water content of the butter.

A thesis submitted by Perry C. Ranney for the Bachelor of Science in Agriculture degree, summarized by Prof. Farrington, discussed the influence of changes of temperature on the results obtained with the lactometer in calculating milk solids. The observations made showed that when lactometer readings are taken at temperatures above 70° F., they should not be corrected by the short method which was explained, unless this method is modified so as to make a larger correction for temperature than .1 for each degree of temperature. When readings are taken below 50° F., there is not so much danger of inaccuracy by using the short method of adding or substracting .1 for each degree of temperature. Fleischman's or Vrith's table should be used for very accurate work in correcting temperature; but these tables do not seem to correct quite high enough lactometer readings taken above 80°. It was therefore advised that for accurate work in using Dr. Babcock's formula for determining the total solids in milk, the lactometer readings of milk should be taken at 60° F., thus eliminating all errors of correcting for temperature. Elaborate tables accompanied the report.

A thesis submitted by John Michels for the degree of Master of Science in Agriculture in 1905 and abstracted by Dr. Russell, presented results on the relation of lactic acid bacteria to the formation of butter flavor in milk serum, and also on the origin of butter flavor. From the data obtained, it was apparent that the development of desirable flavors in butter may be made independent of the butter fat in cream, and that the growth of the lactic acid bacteria in the milk serum results in the formation of by-products which are readily absorbed by the butter fat, and give the characteristic flavor to the butter. This would indicate that the fat itself does not enter into the process, except in a passive way. The germ content of butter made from cream to which a ripened skim milk starter had been added, generally proved less than that of butter made in the usual way.

Dr. Russell and Conrad Hoffmann reported in 1905, on a bacterial test they had made of a bottle-washing and sterilizing machine devised by Rice and Adams of Buffalo, New York by means of which apparatus 2 men could easily handle from 2,400 to 4,000 bottles an hour. An illustration of the machine accompanied the text. When steaming with the machine was continued for a period of 20 seconds, the machine could handle 2,160 bottles per hour, but even when exposed for 30 seconds the bottles were by no means rendered sterile. A longer ex-exposure would, therefore, be advisable.

Dr. Russell also made in 1905 studies on pasteurization of milk in the Miller "continuous flow" machine. Such a machine allows the treatment of a large volume of milk per unit of time, but that is at the expense of a great reduction in the period to which the milk is actually heated. It was thought advisable to determine, with some degree of exactness, the length of exposure permitted by the machine, and also the regularity in the rate of flow of the milk. It was found that some of the milk goes through the apparatus in about 15 seconds, when running at standard full capacity. Most of the milk, however, remains in the machine about 30 seconds and some is even held for about 45 seconds. It is important, for effective pasteurization, that the length of time in the machine should be increased as much as possible. When the time of exposure to heat is very short, at least some portions of the milk will be likely to escape thorough destruction of even growing bacteria. Prolonged exposure, however, so limits the capacity of the apparatus as to make it impracticable, where a large volume of milk is handled. It was stated, from bacteriological examination of milk pasteurized in the Miller apparatus, that temperatures of 176 - 185° F. yield as good results as in any of the reservoir type, but at these temperatures a more or less pronounced cooked taste is imparted to the milk, as well as to its creaming properties. When the milk is brought to a temperature of 158 - 160° F., the cream rises normally. If, however, the temperature is raised to 168° F., not more than one-half of the cream separates clearly from the milk. Ideal pasteurization must be expressed, not only in an enhanced keeping quality of the milk, but in a distruction of microbic life that is fairly effective. The rate of flow with a full head of milk, in the Miller apparatus, approximated about 1800 lbs. per hour. The period of actual exposure ranged from 15 to about 45-50 seconds.

Milk exposed for but 15 seconds at a temperature only slightly above the thermal death point of microorganisms cannot have its germ life as effectively destroyed as that which receives a more prolonged treatment. In the tests, the bacterial counts in most cases, were greatly increased where the temperature fell below 150° F., and the milk had a shorter keeping quality. If a temperature of not less than 160° F. is maintained, the bacterial content of milk will be fairly satisfactory, although not nearly so low as when a longer application is made at a lower temperature, and the keeping quality is very satisfactory. As previously shown by tests reported in the 21st Annual Report of the Station, an exposure of 160° F. for one to two minutes suffices to destroy the tubercle bacillus which is the organism most to be feared in milk. In 1905 Dr. Russell and R. A. Moore conducted experiments in the inoculation of alfalfa and soybeans. The seeds used were disinfected by immersing them in a 1 to 1,000 solution of corrosive sublimate for a period of 10 minutes and then thoroughly rinsed in sterile distilled water. The report on the experiments was instructively illustrated. With alfalfa, inoculation with soil emulsions or soil scattered broadcast over test plots proved more effective than treatment of the seeds with bacterial cultures, such as that of the Nitro-Culture Company, or one furnished by the U. S. Department of Agriculture. Inoculation of alfalfa with soil from sweet clover ~~nodules~~ fields or with emulsions made from sweet clover nodules, proved effective. Nodules failed to form on soybean plants where the government cultures and nitro-cultures had been used, but did so when the seed was infected with soil from an old soybean field. Soil inoculations were therefore recommended as preferable. Inoculation of field peas was not deemed necessary, as the soils tested furnished the necessary nodule-producing organism.

In view of a plan proposed for carrying on sytematic studies of the soils of Wisconsin Prof. Whitson and C. W. Stoddard published in the 22nd Annual Report of the Experiment, an introductory paper on the subject, which was accompanied by a colored map of the state showing the distribution of 11 different classes of soils. The map was based primarily upon the general Map of the Soils of Wisconsin, published by Prof. T. C. Chamberlain in the report of the Geological Survey in 1882, with modifications relating to the North Central areas of the state, based on the work of Dr. Samuel Weidman, geologist of the state geological and natural history survey, as published in Bulletin No. 11 of that survey. There was in preparation a bulletin on the soils of the state which would more fully describe the various classes of soils. The introductory paper gave only a brief statement of their distribution and character, together with such analyses as had been made up to the time of its preparation.

Prof. Whitson, L. P. Hoskins and O. G. Malde also presented results of the continued investigations on cranberry production. The season of 1905 had been unfavorable for large production, flood conditions in some districts and early frosts having proved injurious. The fruit worm had also caused some damage. The report gave information about irrigation and drainage, effect of varying temperatures, the relation of frost formation to humidity, sanding, fertilizers, culture methods and cranberry diseases and enemies.

Prof. Sandsten reported on excessive feeding as a factor in producing variation in tomatoes. Many illustrations accompanied the text. The Horticultural Department had succeeded in producing a seedless tomato which might, at least, be of value to plant breeders from a scientific standpoint. Excessive applications of fertilizers resulted in scarcely two plants in a bed of ninety-six being alike in all particulars. From his investigations Sandsten concluded that a large share of abnormalities occurring in both plants and animals are due to excessive feeding, coupled with other abnormal conditions. While sexual mixing had been generally regarded as the only way of producing variation or of breaking up the type, he was of the opinion that natural and artificial environment, especially the latter, can and do produce extreme variations when patiently and intelligently directed.

C. Bues, nursery inspector, gave directions for checking the ravages of the cottony scale which frequently causes great havoc and even death to soft maple trees. Results of spraying with kerosene emulsion were detailed and illustrated. Bues also gave an account of state nursing inspection done in 1905, and notes regarding the various pests of trees and methods for their control.

Prof. Moore and A. L. Stone continued their variety tests of grain and forage plants in 1905. Grains that had shown merit through several years' tests were retained for these trials. Several new varieties of oats, rye and barley were tested for the first time. A new field of about 5 acres had been turned over to the Agronomy Department and laid out in plots containing one-twentieth of an acre each. Of barley, the Oderbrucker (Wisconsin No. 55) and Improved Mornshury, (Wisconsin No. 62) were the most satisfactory varieties tried. Of oats, Swedish Select, the White Bedford, American Banner, and Wisconsin Wonder gave good returns, and showed the most desirable characteristics. Four varieties of rye, grown from seed furnished by the U. S. Department of Agriculture, gave exceptionally good yields. The wheats grown were of winter varieties furnished by the government and did well. As regards soybeans, the effect of inoculation were not apparent on rich soils, but were very noticeable on the poorer grades of soils. Nodules appeared on the plant~~s~~ roots the first year, where the ground had been inoculated, and in three years where inoculating had not been done. With alfalfa, no advantage was obtained by sowing Turkestan or European varieties, over those grown in the United States. Foreign seed was somewhat more expensive and usually was contaminated with weed seeds. Hay caps were considered essential in curing heavy growths of alfalfa. Corn breeding on the Station Farm was confined to an effort to establish earlier maturing qualities in some of the later, heavy yielding varieties of yellow dent corn, to better fit them for Wisconsin conditions. Work was done with 40 varieties of corn. Silver King Corn (Wisconsin No. 7) was again grown on the Station Farm for general purposes and gave satisfactory returns. Two hundred and seventy-five members of the Wisconsin Experiment Association carried on tests with this variety of corn, during 1905, in various parts of the state.

The average production per acre was 59.2 bushels, or an average of 10 bushels per acre over other varieties on trial. Tests with fertilizers were also conducted, and barley smut investigations continued. Tests made in 241 barley fields in 25 different counties of the state in 1905 showed 7.16 per cent of smut. Treatment of barley seed with a solution of formaldehyde was effective as a preventive, but solutions stronger than 1 pint of formaldehyde to 20 gallons of water were apt to injure the germinating power of the grain, especially were it immersed in the solution for as long a time as 24 hours before sowing.

G. N. Knapp reported that 716 silos were in use in Wisconsin in 1905 and furnished statistics relative to accidents by farm machinery.

PROGRESS in 1905-1906

The University having purchased three acres of land immediately south of Linden Drive and running to University Avenue in front of Agricultural Hall, erection of a building for the Department of Agricultural Engineering, and another for the Department of Agronomy was proceeding and to be completed, if possible, by January 1, 1907. The two buildings were being made fire-proof by employment of brick, cement, steel and tile in their construction. Other recent purchases of land included a tract of two and three-fourths acres close to the agricultural buildings and thirty acres, known as the Alvers land, adjoining the University Farm proper along its western border and to be used for general farm purposes. The thirty-acre portion of Camp Randall which had for some years been used by the Experiment Station had become unavailable for that purpose. A tobacco curing house was constructed and put into use in the autumn of 1905.

BRANCH STATIONS ESTABLISHED

1905-06?

During the year branch experiment stations were established in the region south of Lake Superior, one on the County Poor Farm in Douglas County, a second within the corporation limits of Iron River, Bayfield County, and a third within the city limits of Ashland, Ashland County. The citizens of these districts rendered helpful assistance in the inauguration of the branch stations and to make possible, through them, beginnings of real agricultural development in the northern region of the state.

In aid of the same region, the Horticultural Department planted an orchard at Bayfield, and another on the (Madeline)? Apostle Islands, Orchard trees were also planted on the Douglas County farm.

The new sub-stations were placed under the joint care of the Departments of Agronomy, Horticulture and Soils.

CHANGES IN THE STATION STAFF

Leslie H. Adams, who for twenty-five years, had been connected with the University Farm and in recent years Farm Superintendent, closed his services June 15, 1906 to engage in farming in Michigan on his own account.

Assistant Prof. G. N. Knapp having resigned, Charles Albert Ocock, a native of Illinois who had obtained the Bachelor of Science in Agriculture degree from the University of Illinois in 1904, was given charge of the Department of Agricultural Engineering. He had served as an assistant from July 1906, was made assistant professor July 1907, and served until July 1913 when he resigned on account of ill health. Later he was agricultural engineer of the Avery Company, Peoria, Illinois, and then with the J. I. Case Company of Racine, Wisconsin, as experimentalist. While at Wisconsin, Professor Ocock did notable work on ventilation of farm buildings, concrete construction of silos, fence posts, etc. He prepared a tentative floor-plan for the new agricultural engineering building which was accepted by University Architect Peabody, with but one minor change. Among his other accomplishments as an agricultural engineer while at the Wisconsin Station, was the origination of the collapsible forms for concrete silo construction which were widely used by "Farmer Circuits" of builders, and the "Blue Prints of Farm Buildings for Farmers" which were distributed and used for several years by farmers and contractors in many districts of Wisconsin. His bulletins on silo construction and ventilation proved popular and instructive, and he came to be known, by many farmers and cement manufacturers, as "The father of the concrete silo". He worked out a course of study in agricultural engineering in 1906, which was one of the first of its kind, and did useful work relative to poultry house construction and in promoting the general use of scientifically constructed septic tanks on the farm. He has been a profuse and instructive writer on his specialties for the farm press and power magazines and deserves credit for his efforts in building up the Agricultural Engineering Department and laying a foundation for scholastic and experimental work in his line.

The coming of Edwin Brette Hart to the Experiment Station in 1906 as chemist and Professor of Agricultural Chemistry was an epochal event, for he was destined to accomplish wonders in his vocation. He was born and reared on a farm at Sandusky, Ohio, obtained the Bachelor of Science degree from the University of Michigan in 1897 and rounded out his education by courses taken at the University of Heidelberg and Marburg, Germany in 1900-1. Before coming to Wisconsin, through the good offices of Dr. S. M. Babcock, he had served as assistant chemist of the New York Agricultural Experiment Station at Geneva, from 1897 to 1902 and as associate chemist, from 1902 to 1906. He is a fellow of the American Association for the Advancement of Science and author of the two important text books, "General Agricultural Chemistry", 1910, and "Chemistry and its Relation to Daily Life", 1913. Gifted with originality, far-seeing vision, ability as an organizer, and notable industry and perseverance, he quickly built up a strong Department of Agricultural Chemistry and became nationally famous for his purposeful achievements as a research worker in animal nutrition. Bringing to his assistance other efficient chemists and directing their work with the wise cooperation and counsel of Dr. Babcock, great discoveries resulted, with practical benefit to farmers and inspiration to other scientists in his field of investigational effort. The studies of himself and staff were, from the first, in close cooperation with those of Prof. Humphrey and the other members of the Department of Animal Husbandry, and began with experiments to determine the effect of phosphates in the ration of young pigs. The story of his accomplishments will be told in summaries of the bulletins from his pen which, in due course, were published by the Station.

Another eminent new member of the staff of the Agricultural Chemistry Department was William Edward Tottingham, who came from Templeton, Massachusetts, where he had been reared on a farm. He had served as assistant chemist of the Mass. Experiment Station from 1903 to 1904, and had been a fellow in Chemistry at Mass. Agricultural College, 1904-5 and assistant chemist of the New York Experiment Station, Geneva, 1905-6. In 1903 he had obtained the Bachelor of Science degree from Mass. Agricultural College. He replaced J. C. Brown as instructor in Agricultural Chemistry and assistant in Chemistry, at the Wisconsin Experiment Station where he began work in the autumn of 1906. Continuing his studies there, he was granted the Master's degree in 1908, and in 1917 he obtained the Ph.D. degree from Johns Hopkins University.

He soon made a useful place for himself in the department and developed an important course in Plant Biochemistry, which emphasized the importance of Plant Physiology to which he then continued to give much attention. He has specialized in the relations of climatic factors to plant metabolism, and from 1913 on, published many research papers on various phases of his specialties. Using physiological technics as a means to an end, he has always kept paramount the chemical aspects of plant problems. He is a Fellow of the A.A.A.A. and had served as President of the American Society of Plant Physiologists. He was the author with Prof. E. B. Hart, of the text book, "General Agricultural Chemistry" and with Prof. J. W. Ince, now chemist of Rhode Island State College, of "Chemistry of the Farm and Home". Facts discovered by him have been recorded in 30 or more research articles and bulletins published by himself and associates.

Edmond Joseph Delwiche who came from Belgium in 1874, where he had been raised on a farm, was given charge of the three Superior, Wisconsin, Sub-Experiment Station farms, with headquarters at Iron River, just after graduating Bachelor of Science, with the class of 1906 of the Wisconsin College of Agriculture. Continuing his studies, he earned the Master's degree in 1909. He was superintendent of the branch stations until 1909 and from 1909 to 1912 was assistant professor of agronomy and superintendent; associate professor, 1913 to 1919, and since 1920 has been professor of agronomy and superintendent of the Northern Sub-Experiment Stations. To him is due the credit for much of the careful, practical and useful work accomplished at those stations in the development of varieties of corn, other grains and forage crops adapted for successful growth in the Northern counties of the state. The production of Wisconsin No. 25, a new variety originated at the Spooner Station, for instance, proved the means of extending the culture of corn to large sections of the

State where corn had not previously been widely grown. Work with oats, wheat, soybeans, peas, alfalfas, clover and root crops has been equally successful under his supervision.

c. 1906

James Garfield Milward, of Madison, was appointed assistant in Horticulture. He obtained the Bachelor of Science degree from the University of Wisconsin, in 1907, and the Master's degree in 1909, and later was made Professor of Horticulture and Secretary of the Wisconsin Potato Growers' Association. The growing of potatoes, especially on the lighter and Northern soils of the state, became the chief subject of his study, research and extension work. He has arranged and supervised many exhibitions of potatoes and has served expertly as a judge of these tubers on many occasions.

A. F. McLeod, Ph.D., a graduate of the University of Chicago, was appointed Instructor and Assistant in Soils at the Station; Conrad Hoffmann, B.S., of the graduating class of 1906, Wisconsin College of Agriculture, was appointed Assistant in Agricultural Bacteriology, and Chris Schroeder, B.S., of the same class, was made Assistant in Animal Husbandry, in place of James Hulton. The latter had been given a similar position at the Agricultural Experiment Station of Colorado to assist in breeding experiments in light horse production, undertaken by that Institution in cooperation with the U. S. Department of Agriculture. Roy J. Harris, who for several years had been engaged in dairy testing and feed inspection work for the Station, was made Official Dairy Tester. W. S. Brown, of the Horticultural Department, resigned. Miss Iva A. Welsh, B. L., a graduate of Wisconsin University and employee of the State Historical Library, succeeded Mrs. S. M. Briggs as librarian in the College of Agriculture. The latter then took charge of the University Law Library.

ERADICATION OF TUBERCULOSIS

During a period of 90 days ending May 15, 1906, 5,500 doses of tuberculin were sent out by the Department of Bacteriology and by this means 600 bovine animals were detected as tuberculous and eliminated. Public demonstrations of tuberculin testing and slaughter tests of tuberculous animals were conducted by Dr. Russell on the State Fair grounds at Milwaukee, in conjunction with the state Veterinarian and aroused keen attention. Similar demonstrations were likewise given at the Experiment Station before assemblages of members of the state Legislature, agricultural students and the general public.

During the fiscal year, July 1, 1905 to June 30, 1906, the Experiment Station published Bulletins No. 127 to No. 137, inclusive, of which numbers 130 and 134 pertained to the licensed commercial feeding stuffs and licensed commercial fertilizers analyzed during the year.

IMPROVEMENT OF HORSE - BREEDING

The first bulletin of the year was No. 127, of 128 pages, issued August 1905. It was written by Dr. A. S. Alexander, veterinarian and Director of the new Department of Horse Breeding and offered advice which, if carried into practice would, it was hoped, lead to the improvement of the horses of the state. It dealt chiefly with matters pertaining to the breeding of draft and coach horses, but described and illustrated all modern breeds, and gave a thorough exposition of the fundamental principles underlying scientific and practical breeding and development of horses for all forms of service. At the time of its publication there were in Wisconsin 567,554 horses of all ages, valued at $48,921,705.00, or an average of $86 per head. Many of the original photographs used in illustrating the text were supplied by James G. Fuller of the Department of Animal Husbandry. The subjects fully discussed in a clear and instructive manner included: uniformity and persistency in breeding; grade sires objectionable; cross-bred sires unreliable as breeders; value of pedigree; recording and publication of pedigrees; importance of soundness in breeding stock; selection of breeding stock; importance of generous feeding; over-fat condition objectionable; obtaining suitable stallions; need of local horse-breeding associations; need of cooperative methods; training hoofs and shoeing; preventing navel and joint disease of foals; the breeds of horses; marketing horses; market classes; points of the draft horse (with score card); and points of the light horse (with score card). Special articles on some phases of the subject were also furnished for the bulletin by noted experts as follows: "Horses for city teaming", by James G. Boyd; "Draft horse breeding in Wisconsin", by H. A. Briggs; "Fitting horses for show", by Alexander Galbraith; "Care and feeding of draft stallions during the breeding season", by Alexander Galbraith; "Breeding Coach horses", by I. R. Ives; "The general purpose horse", George McKerrow; "Feeding farm work horses", James Z. McLay; "Developing draft foals and care of brood mares"; Robert B. Ogilvie; and "The care and management of stallions", F. C. Warren. The bulletin also contained a list of American and foreign stud books, recognized by the U. S. Department of Agriculture, Washington, D. C.; a copy of the law regulating the public service of stallions in Wisconsin, which had been written by Dr. A. S. Alexander and enacted by the Legislature in 1905, approved April 22, 1905 and to be in force from and after January 1, 1906, and synopses of other existing laws relating to animals for public service. Forty thousand copies of the bulletin were published.

DAIRY RESEARCH BULLETINS

In Bulletin 128 of September 1905, by Dr. H. L. Russell and E. G. Hastings, particulars were given regarding a trouble in Swiss cheese caused by a gas-forming yeast. During the previous year a defective condition in Swiss cheese had proved so serious that the matter was thoroughly investigated by the bacteriologists mentioned. They found that the trouble was caused by a yeast which was able to ferment milk sugar, producing alcohol, carbonic acid and other products. The conditions in old whey were found ideal for growth of the objectionable yeast. To prevent the trouble it was advised that where rennet milk-curdling extracts were made by soaking whole rennets in whey, the whey should first be boiled. Doing so would minimize the danger of introducing undesirable germs;

but the use of the commercial rennet extract would entirely do away with the trouble. If it were considered necessary to develop some acidity, that could be done by the use of a little lactic acid ferment, in conjunction with the commercial extract. The bulletin was also published in the German language.

In Bulletin No. 129 of September 1905 Prof. E. H. Farrington discussed some creamery problems in an instructive manner. The subjects considered were; Care of cream at the farm; overrun from milk and cream; calculating overrun for milk and for cream patrons at the same factories; cleaning test bottles; and an alkaline tablet solution measuring bottle.

In Bulletin No. 131 of December 1905 Prof. Woll reported the official tests of dairy cows made in 1904-5, as a continuation of the work begun by the Experiment Station in the middle of the eighties, and under his direction since 1899. He also presented in Bulletin No. 132 of December 1905 full particulars regarding the manufacture of whey butter at Swiss cheese factories. An edition of the bulletin was also published in German. The bulletin announced that a good quality of sweet cream can be obtained by skimming Swiss cheese whey with a centrifugal cream separator. The whey often tests 1 per cent of butter fat. Churning the whey daily was advised as better than accumulating the cream several days before churning. Butter salt and butter color should be used. The amount of whey butter can be greatly increased by skimming with a separator and ripening, and churning the cream so as to reduce the usual large losses in the skim milks and buttermilks. The quality, and the water content, of separator whey butter may be made equal to that of creamery butter, as the cream obtained by skimming the whey is sweet and need not contain any objectionable flavors. Advice was given relative to the machinery needed for such butter-making, and instructions given for their proper use.

COMBATING TUBERCULOSIS

As a further move in the war against bovine tuberculosis waged by Dr. H. L. Russell, he, with E. G. Hastings, issued Bulletin No. 33 in February 1906, to inform cattle owners regarding the distribution of the disease in suspected and non-suspected herds in Wisconsin. It was the fifth bulletin of the series on the subject. They published the bulletin in view of the fact that "An ~~enemimg~~ enemy in ambush is much more feared than one in the open, because there is always an element of uncertainty as to the strength of the opposing force". So is it with the struggle against tuberculosis. They advocated, therefore, the wide employment of tuberculin to unmask the presence of the foe for final eradication. Results of tests were cited and explained; then full instructions were given as to the correct method of applying the test and interpreting the reaction of tuberculin; and as to the disposal of tuberculous animals, and disinfection. In this connection stock owners were offered, free, a special bulletin on barn disinfection published by the Wisconsin Live Stock Sanitary Board. It was stated, also, that the U. S. Department of Agriculture was preparing supplies of tuberculin for distribution, free, under certain conditions. A blank on which to apply for tuberculin was printed in an appendix to the bulletin. Twenty-five thousand copies of the bulletin were printed.

SPRAYING POTATOES

Prof. Sandsten and J. G. Milward, in Bulletin No. 135, of April, 1906, gave instructions for the spraying of potatoes to prevent leaf blight and rot. Spraying experiments had been conducted on the farm of S. S. Chandler at Waupaca in 1905 and on other farms at Colfax. Applications of Bordeaux mixture had given good results; instructions were therefore furnished for preparation of the mixture, and its proper use, and information given relative to the time of spraying, effect of the mixture, the machines to be used, and the cost of the operation. Failures in spraying had generally been attributable to application of the mixture too late or at improper time. It was advised that the application should be thorough, the mixture of standard strength and properly made and applied before appearance of disease, and to be repeated immediately, should a heavy rain occur.

Mrs. L. H. Adams and Prof. Sandsten, in Bulletin No. 136 of April 1906 offered practical suggestions for preserving native fruits and vegetables. The growing and preserving of native plums in various ways were particularly advised. The recipes given had been carefully tested and found worth while by Mrs. Adams. Similar recipes were furnished for the preservation of strawberries, red and black raspberries and gooseberries; also for the canning of tomatoes and corn and the making of pickles, together with advice relative to the storing of preserves, fruits and vegetables.

In Bulletin No. 137 of April 1906 Prof. Sandsten presented a report, with elaborate tables, on the conditions which effect the time of the annual flowering of fruit trees. One interesting point made was that a heavy crop invariably delays the formation of fruit-buds and causes the latter to enter the winter stage partially developed; also, that there is little relationship between the time of flowering and the temperature in spring, up to the time of flowering, while there appears to be considerable evidence that the temperature and other climatic conditions during the summer and fall preceding flowering, has much to do with the time of flowering.

In addition to the bulletins published during the year, synopses of other work accomplished at the Experiment Station were given in the 23rd Annual Report published in the autumn of 1906.

ANIMAL NUTRITION WORK

Results of the tenth year's test of feeding whole corn in comparison with cornmeal for fattening pigs were reported by Director Henry and D. H. Otis. Three tests had been made during the year, and these were to complete the experiments on the subject by the Experiment Station. During the ten years, eighteen trials had been made with a total of 280 pigs, one-half of them receiving whole corn, and the other half, corn meal. Tables presented detailed statistics of the entire number of tests. Conclusions followed the tables. Among others, it was stated that where there is plenty of time for maturing pigs, and it is not necessary to secure the maximum daily gain, it is doubtful whether it pays to grind corn for these animals. Where quick maturity is an important item, better results are secured from the corn meal. Pigs fed corn meal, eat more grain and make somewhat larger daily gains. When fitting hogs for show, sale or in high pressure feeding for market, it may be advisable to grind the corn, even though it is expensive to do so.

Prof. Humphrey and J. G. Fuller reported their third trial conducted to compare the value of soybean meal and wheat middlings as a supplement to corn meal, for growing and fattening pigs. A page plate, accompanying the text, pictured cross-sections of the hogs tested, and showed the distribution of fat and lean in the different animals. The even distribution of fat and lean was superior in the pigs fed wheat middlings and cornmeal than in those fed soybeans and cornmeal, as was firmness, fine grain and texture of flesh. Soybean meal was, however, found from 8 to 10 per cent more valuable than wheat middlings, for economical pork production when the cost of the two feeds was the same. Soybean meal mixed with corn meal in the proportion of 1:2, produced greater gains than wheat middlings and corn meal fed in the same proportion. The experimenters, therefore, advised that "soybean meal makes an excellent supplement to corn meal for growing and fattening pigs."

Prof. Humphrey and Frank Kleinheinz had continued their experiments in the winter production of lambs. They reported difficulty in getting ewes to breed early enough to produce lambs for such tests. Pure-bred and grade Dorset ewes, in good condition, might be depended upon to breed in July. (While that was true only in exceptional cases, as regards other breeds.) Use of a Southdown ram having given compactness and excellent mutton quality to the lambs, that breed was recommended for crossing with the ewes of Dorset breeding. The high price of $9 a head received for the lambs produced emphasized the fact that it pays to produce something of special value and cater to a high class trade which demands the best possible quality of product.

Prof. Humphrey and Frank Kleinheinz also fed dried beet pulp to 10 lambs for 13 weeks in 1906 along with an equal allowance of whole oats, and fed another lot of 10 lambs equal parts of whole oats and shelled corn. Both lots were fed as much clover hay as they cared to eat. The ration of whole oats and shelled corn produced a slightly greater gain in live weight, and a slight saving in the amount of hay consumed, compared with the ration containing beet pulp; but both beet pulp and shelled corn were pronounced satisfactory and practically equal for producing growth, when used in connection with whole oats and clover hay.

In the 23rd Annual Report J. G. Fuller described and illustrated in an instructive manner different types of portable hog houses in use at the University Farm. He advised that by the use of such houses the swine producer can readily enlarge his accommodations as the size of his herd increases, and avoid the mud and vermin which accumulate around a large hog house. That may be further accomplished by accoasionally moving the "cots" or "colony houses" onto new plots of ground.

Professors Humphrey and Woll again furnished an Annual Report on the University Dairy herd, with particulars regarding the rations fed, the production records of the various cows, a comparison of the breeds, and notes on methods of management.

Dr. Russell and E. G. Hastings followed with an account of the tuberculosis work done in 1905-1906, in which they explained the general principles of using the tuberculin test and reported the results obtained by application of the test to herds in various parts of the state.

BACTERIOLOGICAL AND SOILS WORK

Bacteriologist Hastings, in the 23rd Annual Report, described and illustrated a type of cheap and effective laboratory incubator which during 1906 had been used with success by the Bacteriology experts of the Experiment Station. This incubator, with regulabor and heating apparatus, had been installed at a cost of about $60 and had proved so effective that it was recommended for more general use; hence the description presented.

Conrad Hoffman, assistant in bacteriology, furnished a report on the relation of soil bacteria to nitrogenous decomposition. His experiments showed that the numbers and character of the bacterial flora in soils are largely influenced by the nature ~~native~~ of the fertilizers applied and by the character of the soils themselves. The number in sand was found to be only about one-fifth of that ih black marsh soil. The total number of bacteria developed in richly fertilized soil aggregated hundreds of millions, per gram, and the degree of nitrogenous decomposition is, in a general way, dependent upon the total number of bacteria present in a soil. Excessive ammonification invariably occurs before nitrification becomes active. Appreciable amounts of ammonia are invariably present in highly fertilized soils. The degree of decomposition in the soils tested ranked: 1-black, marshy soil; 2-clay; 3-sandy loam and sand. Based upon their relative susceptibility to decomposition, the fertilizers used ranked thus: blood meal, bran, bonemeal, peat. The use of anaerobic conditions had no advantage over the aerobic method, but was found far more difficult to manipulate.

Prof. Whitson, O. G. Malde and C. B. Hardenberg reported that the cranberry season of 1906 had been favorable for production of a fairly good crop; but blight, fire, and fruit worms had caused considerable loss. Their report gave information about irrigation and drainage; suitable soils and fertilizers; insect enemies; and methods of preventing injuries by worms, Spraying with arsenates had proved both a preventive and cure for noxious insects. Flooding could not be relied upon to act as a remedy for the fruit worm, unless sufficient water at a low temperature can be supplied from a stream or lake. The submersion should continue for at least 36 hours. The use of torches was not found to be a satisfactory preventive. Clean culture was advised. Both fruit worms and black-headed vine-worms were found to be attacked by a special parasite, the species of which had not yet been determined. The percentage of the parasite infestation was, however, so slight that its presence could not be relied upon to keep the worms in check.

Prof. Whitson, C. W. Stoddard and A. F. McLeod, recognizing the importance of nitrogen as an element of plant nutrition, undertook a full study of the changes in the nitrogen content of field soil under various systems of farming. They found that in 6 out of 21 cases the difference in amount of nitrogen in the virgin soil and cropped soil is not enough to account for the crops which had been removed. It was established that there are other classes of bacteria than those which form tubercles on the roots of leguminous plants, which have the power of fixing nitrogen from the soil air, and to them might be attributed the presence of added nitrogen in the cases mentioned. The loss by leaching and denitrification were shown by the tests to average only 22.3 per cent of the amount of nitrogen removed by crops. The indications were that in clay loam soils of moderate fertility, more than four-fifths of the nitrogen lost was removed by crops. In soils of a higher degree of fertility and especially where large amounts of fertilizers had been applied, to late cultivated crops, there is a larger loss of nitrogen by leaching and denitrification; but the entire loss of nitrogen from such fields would average but 37.1 per cent of the original content of nitrogen. The importance of maintaining the store of nitrogen by the growth of clover or other legumes was stressed.

Prof. Whitson and C. W. Stoddard also reported on the availability of phosphates in relation to soil acidity. The results attained by their investigations indicated that whenever a soil falls below .11 per cent of calcium carbonate content, it will be acid or at least in a condition to become acid very soon. They concluded that acid soils need phosphates and that it would be possible by a careful test of a soil with litmus paper, to tell if it needs or will need in the immediate future, application of a phosphate fertilizer.

Prof. Whitson, E. J. Delwiche and E. R. Jones began, in 1906, field experiments on two classes of sandy soils, one at Sparta, on the residual soils from Potsdam sandstone, and the other at Iron River, on glacial sands. They also conducted experiments of marsh soil, the results of which, in part, were reported in Bulletin No. 138 on Land Drainage. Another bulletin, completing the report, was soon to be issued. Experimental fields on peat had been laid out at Marinette in 1904, and in 1906 at Phillips and Mather. The results at Marinette indicated that phosphorus was the element most lacking in the soil there, and that potash is also beneficial. Applications of artificial fertilizers the second year did not greatly increase the crop of hay on foul meadow-grass plots. Lime was not found beneficial. At Phillips the effect of limestone applied at the rate of 600 lbs. per acre, was quite noticeable. A high degree of acidity in the soil appeared to be the cause of failure of the grass seed to grow. Lime not having proved beneficial at Marinette, it was not used at Phillips. Four loads of wood ashes applied per acre greatly benefitted the growth of barley. On coarse peat soil at Mather phosphates and potash, especially phosphate, had a marked effect on grasses, and potatoes succeeded well. For the red clay soils of the Superior region under-drainage was prescribed as the most important improvement. Surface dressing of manure was suggested as another promising improvement, in addition to the growth of grasses and clover, to increase the humus content. Three fields were also laid out at the Ashland substation for soil studies, fertilizer and drainage tests.

Prof. Sandsten announced in the 23rd Annual Report that the work of improving the native plums, which had been begun by the late Prof. E. S. Goff about twelve years earlier, would be brought to conclusion at the end of another season. Out of a total of over 50,000 seedlings grown from the standard varieties, five or six superior varieties had been selected, were being propagated, and would soon be distributed for more extensive trials. It had been proved by the experimental work done at the Station, that the native plum comes true, or nearly true, from seed and that little variation had resulted from pollination, even where the trees had been grown closely together. It had been concluded that high culture and persistent selection would accomplish more for the native plum than direct crossing between the existing native varieties. Attempts to cross the native plum with the Japanese and European varieties had been unsatisfactory, but the work was to be continued.

Several very promising varieties of seedling apples were being propagated in the experimental apple orchard at the Station and, later, would be sent out for trial.

Prof. James G. Moore conducted a variety test and three experiments with radish, tomato, lettuce and cucumber in the Station greenhouses during 1906. The tests with radish had not been completed. With tomatoes, little choice was noticed between plants grown from cuttings and those from seedlings for use in the forcing house; but for the production of two crops of tomatoes, at least a month in favor of the seedlings could be saved in the time during which the plants occupy the bench. In the production of lettuce it was found that in growing two crops, the surface-watered bench yielded nearly 60 lbs. more lettuce than did the sub-irrigated bench. The work with cucumbers was to determine the value of superheated soil, or bottom heat in forcing the plants, but definite conclusions had not yet been made.

Prof. Sandsten and E. J. Delwiche made a preliminary report of work done, for the first time, in 1906, at the Northern Sub-Stations, with potatoes and strawberries. The results showed the value of clover in rotation with potatoes. The work with strawberries had not been completed. A study was also made of the possibilities for fruit growing on the Bayfield Peninsula, and at other points in the Lake Superior region. It was predicted that the Bayfield Peninsula, due to its favorable location, would, in the near future, produce apples and cherries sufficient to supply the immediate wants of the near-by markets. Ten acres of apples, plums and cherries had been planted on the farm of John Walters, 2 miles south of Bayfield, five acres of apples, plums and cherries on Madeline Island on land belonging to E. P. Salmon, and six acres on the Douglas County Poor Farm at Superior. The purpose of these plantings was to demonstrate that larger fruits can be grown and to test varieties as to their adaptability to the soil and climate of the northern section.

Prof. James G. Moore also gave a report of the state nursery inspection work done in 1906, and recommended that there should be a law compelling all persons who grow and sell nursery stock within the state to have their premises inspected the same as are nurserymen who carry on an interstate business.

The various injurious insects found on nursery stock were listed in the report, together with particulars about each and the remedies considered most effective for their control.

Prof. R. A. Moore and A. L. Stone gave an illustrated account of the experiments they had conducted with grain and forage crops in 1906. Many new varieties of grains from the United States Department of Agriculture, and other sources were tested. The tests included 27 varieties of oats and 64 of barley, and corn breeding, in accordance with the row system had been done on a large scale.

Swedish Select oats again gave good yields. Beardless, hulless and the two-rowed barleys, again tested, showed weakness of straw and did not fill well. Improved Oderbrucker (Wisconsin No. 55) and Mansury (Wisconsin No. 62) were the most satisfactory barleys grown. There was a difference of 5.9 bushels in favor of barley grown on fall-plowed land, the average being 41.8 bushels per acre on fall plowing, as against 35.9 bushels on spring-plowed land. It was found that the total yield of corn is greater where the selection was made to increase the number of single ears, than where it was to increase the number of double ears. In 1906 the average yield per row of corn was: seed corn, 53.1 lbs; marketable corn, 132.8 lbs; and nubbins, 7.2 lbs. The average yield per acre was 75 bushels. In the forage crop tests alfalfa proved to be hardy as medium red clover, where it was grown under like conditions. Frequent thawing and freezing in early spring was the chief cause of killing of clover and alfalfa. Late fall cutting and pasturing of alfalfa was pronounced injurious. Paying quantities of alfalfa seed could not yet be produced in Wisconsin, but an average of 4 bushels of clover seed per acre was reported by the growers. Ten varieties of winter wheat had been carried through the breeding test. Experimentation, for eight years, had shown Wisconsin soil and climate conditions unfavorable to the satisfactory production of winter wheat. Tests of varieties of ry were also made.

Prof. R. A. Moore and A. L. Stone in 1906, tried out a method of eradicating wild mustard at the suggestion of the American Steel and Wire Company. Tests were made in Dane, Waukesha and Kenosha counties. Their report on the tests presented illustrations of the Platz sprayer imported from Germany, and pictures of the weed and infested grain fields. They found that the plants were practically all destroyed by spraying with a 20 per cent solution of iron sulphate. The spraying should be done on a calm, bright day after the dew has disappeared and when the mustard plants are in the third leaf. Rain falling a few hours after the spraying lessens the destructive effect of the solution. The solution also partially or wholly destroyed daisies, cockleburs, bind weed, ragweed, chicory, sheep sorrel, yellow dock, wild lettuce and many other weeds. One hundred pounds of iron sulphate, dissolved in 52 gallons of water, makes the right solution for spraying. From 20 to 25 acres can be covered in a day, where the sprayer is kept in continuous use.

Prof. Moore and E. J. Delwiche conducted experiments in 1906 at the Northern sub-stations to test and acclimate varieties of grains and forage plants that had proved their worth in southern and central Wisconsin. Pure-bred varieties of barley, oats and corn were grown with a view to disseminating those crops that showed special merits. Alfalfa, soybeans and sugar beets were also grown. The beets yielded 9 tons per acre and when analyzed showed a test of 93.3 in purity, and 16.9 in sugar content.

Prof. Moore and E. G. Hastings, in 1906, continued the tests they had reported in the 22nd Report of the Station, to determine the relative efficiency of various methods of inoculating leguminous crops with cultures of nitrogen-fixing bacteria. The results were in accordance with those obtained in previous years. The tests made in 1905 were with dried cultures. Those of 1906 were made with liquid cultures, and showed practically the same results. Many of the commercial cultures had been found unsatisfactory.

During 1905-6 C. A. Ocock, assistant in agricultural engineering, made investigations to determine the number of farm machines used by the average Wisconsin farmer and to obtain a conservative idea as to the care given these machines. The results obtained were stated in tables showing the different kinds of implements used. Two hundred and seven owners reported the housing of the machines in suitable sheds, while 45 did not house their implements.

Chapter XIV.

The Resignation of Director Henry

RESIGNATION OF DIRECTOR HENRY (1907)

An epochal event in the history of the Wisconsin Agricultural Experiment Station was the resignation of Dean and Director William Arnon Henry, announced in the Twenty-Fourth Annual Report for the fiscal year ending June 30, 1907. After twenty-seven years of strenuous labor in the upbuilding and management of the Station and College of Agriculture and furtherance of agricultural science and practice, he had suffered a nervous breakdown and reluctantly retired to seek relief by rest. In doing so he had the satisfaction of knowing that his work had been of inestimable value in his chosen vocation and an inspiration and incentive to thousands of young agriculturists, research workers and the farmers of not only Wisconsin but of the entire country. His reputation, too, had spread to other countries and there agriculturists had benefited by his investigations and adopted some of his conclusions as sound and worth while.

The Board of Regents of the University made him Emeritus Professor and expressed their appreciation of the services he had rendered in the following resolution, adopted and engrossed June, 1907:

"<u>Resolved</u>, That the Regents of the University of Wisconsin accept with great regret the resignation of Professor William Arnon Henry as Dean of the College of Agriculture and Director of the Experiment Station and hereby appoint him Emeritus Professor in the University.

"In taking this action the Regents desire to express to Professor Henry their profound appreciation of his distinguished service in the cause of agricultural education in the state and nation during the twenty-seven years of his connection with the University, a service that has contributed much to the advancement and prosperity of the Commonwealth and placed all its citizens under obligations to him.

"They tender to him the assurance of their continued regard and high esteem, and express the hope that relief from the burden of executive duties may restore his health and strength, now impaired by long devotion to the service of the state."

The hope expressed by the Regents was to be realized, for Professor Henry revived materially in spirits and bodily vigor when, for a time, he took an active part in the management of a fruit farm near Wallingford, Connecticut, upon which he had established his only child, Arnon Taylor Henry and family, and later at Sarasota, Florida, where he engaged in the real estate business until he joined his sister at San Diego, California. At the latter place he spent his declining days in peace, though gradually becoming frail in body. Much of his time there was happily spent in a park near his home, among the luxurient botanical treasures of that salubrious climate, in which he took a scientific and enthusiastic interest and charmingly described and explained, on many occasions, to groups of young botanical students and lovers of nature. There he passed peacefully away on November 24, 1932.

Commenting on Dean Henry's life, Dr. E. A. Birge, President Emeritus of the University of Wisconsin, wrote, in December 1932: "Both theory and practice found their man in Dean Henry, and the man embodied the full measure of a great opportunity. xxx In the years following 1880 agriculture was made new in both theory and practice. In this revolutionary movement Wisconsin was foremost, and in Wisconsin the work and influence of Dean Henry were central. A life of unselfish devotion, of unwearied toil, a life inspired by wisdom, wrought out great things in a quarter of a century. In University and state and through them, in nation, his work remains, the enduring memorial of a teacher, a scientist, and a statesman."

Dr. Harry Luman Russell, who, for the past fourteen years, had been head of the Department of Bacteriology, was elected the new Dean and Director.

NEW MEMBERS OF THE STATION STAFF

Dr. Mazyck P. Ravenel was appointed to fill the vacancy in the Department of Bacteriology caused by the promotion of Dr. Russell. He came to the Station well fitted by training and experience for the work assigned him and with an international reputation as a bacteriologist. He had been assistant medical director and bacteriologist of the Henry Phipps Institute for the study, treatment and prevention of tuberculosis, at Philadelphia, and for eight years was bacteriologist of the Pennsylvania Livestock Sanitary Board, specializing in bovine and human tuberculosis and their interrelations. His work in association with the late Dr. Leonard Pearson, was especially noteworthy and had attracted much attention at home and abroad. It was believed that his wide experience in the field of Animal Pathology would be of especial value in the work he was about to undertake at the Station.

Another notable addition to the staff was Elmer Verner McCollum, a Kansan and graduate of Yale University, who was appointed an instructor in Agricultural Chemistry. He began at once a biochemical study in connection with experimental work on cattle, confined to rations derived from single plant sources which, originally, had been conceived by Dr. Babcock and then organized and begun by Prof. Hart. His most profitable work, while at Wisconsin, was, however, done in relation to the feeding of diets consisting of purified food substances. This resulted in 1912 in the discovery of the first of the fat-soluble vitamins, now called Vitamin A. He also worked out details of the biological method for the analysis of foodstuffs, in conjunction with Prof. Hart, using swine as the subject, after laboratory tests with rats. This procedure disclosed the nature of the dietary deficiencies of cereal grains and other individual foodstuffs. He also worked in scurvy and on phosphorus metabolism, with Prof. Hart and popularized, in the nutritional field, Vitamin B of the water-soluble vitamin group which had been known since 1897, principally to pathologists and was rediscovered by McCollum independently of the knowledge which was in the literature main, resulting from the studies of Eijkman. In 1917 he was appointed Professor of Biochemistry in the School of Hygiene and Public Health of Johns Hopkins University, Baltimore, Maryland, ahd there, surrounded by multitudes of his laboratory "sanitary rats", he is today working away as diligently as ever, delving into the hidden mysteries of nutritional chemistry.

S. K. Suzuki, formerly chemist of the Experiment Station at Formosa, Japan, was made a research assistant in agricultural chemistry.

Karl W. Smith, of Philadelphia, was appointed assistant in agricultural bacteriology, taking the place of Conrad Hoffman, who had been promoted to Instructor in Bacteriology and given charge of most of the field work in tuberculin testing. Mathias Michels was made assistant in dairying and placed in charge of butter and cheese scoring exhibitions. A. J. Rogers, Jr., a 1906 graduate of the Wisconsin College of Agriculture, was appointed assistant in horticulture and placed in charge of field work on tobacco and C. S. Knight, a graduate in the class of 1907, was appointed assistant in fertilizers and feed inspection.

Dr. J. L. Sammis was appointed assistant professor of dairying and was to continue the cheese investigations previously inaugurated. During 1906 he had been doing cooperative cheese work at the Station for the U. S. Department of Agriculture. Prof. Farrington, Chief of the Department of Dairying, had been given leave of absence for the fiscal year 1907-1908 on account of ill health.

Dr. A. F. McLeod, instructor in the Department of Soils, resigned to accept a position in the University of Chicago, and Miss Louise Jahns was appointed assistant in the department. Prof. A. R. Whitson resumed his duties as head of the Department of Soils after six months' study in Europe.

J. G. Moore who had been promoted from instructor to assistant professor of horticulture, was given charge of the department during the absence of Prof. E. P. Sandsten.

Prof. D. H. Otis was advanced to Associate Professor of Animal Nutrition.

C. A. Ocock to assistant professor in charge of the Agricultural Engineering Department and O. G. Malde was appointed assistant in cranberry investigations and placed in charge of the cranberry station at Cranmoor.

RESOURCES OF THE STATION

During the fiscal year passage by Congress of a law, which had been energetically advocated by Hon. Henry Cullen Adams, materially increased the financial resources of the Station. By its provisions, each state experiment Station ultimately would be given $15,000 a year, in addition to the amount already provided annually by the Hatch Act. The new funds thus provided were to be applied only to paying the necessary expenses of conducting original researches or experiments bearing directly on the agricultural industry of the United States and for the more complete endowment and maintenance of the experiment stations, presupposing the provisions of a working plant and administrative officers.

During 1906-1907 there was to be received from the Adams fund $9,000, which sum was to be increased $2,000 per year until it reached the full amount in 1911.

LANDS AND BUILDINGS

Two tracts of land known as the Corry and King tracts, of two-and-one half acres each and immediately adjacent to the University, were added to the holdings of the College of Agriculture and Experiment Station.

The Agricultural Engineering and Agronomy building which had been in the course of construction during the past year were completed and occupied in 1907. The Agricultural Engineering building, 150 feet long by 50 feet wide and two stories high and with a commodiuus basement for heavy machinery, cost $43,000 and with equipment, when completed, somewhat in excess of $50,000. The Agronomy building, 96 feet by 48 feet and two stories high, with a basement, cost approximately $36,000. A feature of this building was a seed corn fire-drying and curing room.

WORK OF THE DEPARTMENTS

A thorough test of the milking machine was being continued by the Animal Husbandry Department under the practical supervision of W. E. Markey and was producing satisfactory results and settling matters in dispute among dairymen, which promised to prove of much benefit to the dairy industry. An evidence of the success of the Department in swine breeding, largely attributable to the work of J. G. Fuller, was the sale during the year of the Berkshire boar, Star Masterpiece 2nd, at $1,000. This animal later brought the sensational price of $5,500 at auction. Horse breeding was also being successfully conducted at the Hill Farm.

The Department of Agricultural Chemistry, in conjunction with that of Animal Husbandry, had under way an elaborate experiment to determine whether equally balanced rations derived from single and mixed sources have the same nutritive value. In it, calves were being fed exclusively, in different lots, on either corn, oat, or wheat rations, and also on a compounded ration of the three grains. Work by Prof. Hart was bringing out the fact that the function of casein production may be developed independently from that of fat secretion in dairy cows. He had also devised and published a quick method of determining the casein content of milk.

During the past two years the Department of Agronomy had established 600 barley growing and testing centers in the state, and widely disseminated selected varieties through the medium of the Agricultural Experiment Association. Over 1,000 corn centers were also producing and distributing superior varieties of seed at profitable prices.

The experts of the Department of Bacteriology had, during the past year, been making tests to determine whether the presence of blood corpuscles in milk necessarily indicate the presence of pus and, consequently, diseased conditions of the udder. They had already demonstrated by their tests that the standards at that time enforced by many city boards of health, relative to the permissible number of blood cells in wholesome milk were quite unwarranted. It was, therefore, advised that a comprehensive study should be made as to the relation of these cells in health and disease, before a standard is established that is of such vital concern to the dairy industry. The Department had actively continued its campaign against bovine tuberculosis, distributing 12,000 doses of tuberculin, and giving special direction by mail to the application of 10,740 tests.

The Dairy Department had again resumed research work relative to the... (cont.)

role of acids in the manufacture of cheddar cheese, by substituting commercial acids for those biologically produced. About 600 cheeses had been made under varying conditions. The departments of chemistry and bacteriology had participated in the work which was done in cooperation with the U. S. Department of Agriculture. It was under the immediate direction of Dr. J. L. Sammis, who, during 1906-1907 was connected with the Federal department.

During the year G. H. Benkendorf with Mr. Hatch, a student of the Wisconsin Dairy School assisting, developed a simple method of determining moisture in butter, details regarding which were to be published in Bulletin No. 154.

For four years the Horticultural Department had been attempting to improve the quality of tobacco by breeding and selection. A variety thus produced had amply demonstrated superior burning qualities and improved form of leaf was, for the second year, disseminated among growers. Work on curing was being continued, as were the experiments with potatoes to develop blight-resisting varieties. Home prepared insecticides were also tried instead of Paris green, and experiments conducted with potatoes for alcohol production in which considerable interest had been manifested by reason of the commerical development of denatured alcohol.

The Soils Department had continued its studies on peaty and sandy soils and relative to the best methods and effects of land drainage. An experiment in progress sought to determine whether the excess of water in peat cannot be removed by under-draining the substrata of sand. The work on cranberry problems at Cranmoor had been continued along the same general lines as previously reported.

PUBLICATIONS in 1907

During the fiscal year from July 1, 1906 to June 30, 1907 15 bulletins were published by the Experiment Station. They numbered 138 to No. 152, inclusive, of which No. 142 and No. 149 related to the analyses of licensed fertilizers and feeding stuffs made during the year, in accordance with the laws regulating the service. Notes on the chief of these bulletins follow:

Work of the Soils Experts

In Bulletin No. 138 of August 1906, Prof. A. R. Whitson and E. R. Jones presented an important treatise on land drainage. It was practical and educational in the information furnished and embraced facts gleaned from replies to a questionnaire by 129 assessors. They showed that 132,191 acres of land in their townships were practically worthless for farming purposes because of lack of drainage. At that rate there would be about 1,500,000 acres of such unprofitable wet land in Wisconsin. In addition there are 1,000,000 acres of marshy ground, while at least 2,000,000 acres of upland clay soil would also require under-drainage to fit them for the production of maximum crops. The writers of the bulletin believed that the thorough drainage of this 4,500,000 acres of land would increase its value one-hundred million dollars. The bulletin discussed and explained the benefits of tile drainage in all of its phases, the cost of drainage, and the methods of draining various types of land. Maps of various drainage systems were given, and miscellaneous details included to furnish all necessary information and instruction on the subject.

The bulletin on land drainage was followed by Bulletin No. 139 of September 1906, in which Prof. Whitson and C. W. Stoddard explained and illustrated the principles and methods of maintenance of soil fertility. The bulletin matter was presented under three heads, viz.: 1. Chemical composition of soils; 2. Conditions which influence fertility; and 3. Fertilizers. It also mentioned the results of various experiments in corroboration of the facts and advice advanced.

Bulletin No. 140 of September 1906 on development of factory dairying in Wisconsin was prepared by Dr. H. L. Russell and U. S. Baer (assistant dairy and food commissioner) and presented a great map showing the location of all of the creameries and cheese factories in the state, at the time of its preparation. It was the third map of a series. The first was published in 1896, on the basis of data collected for the year 1895 and the second, on a larger scale, in 1901. In preparing the third map the Experiment Station had cooperated with the State Dairy and Food Commission. Every factory in the state had been visited in the course of the regular inspection work of the Commission, and the data thus obtained was incorporated, making the map complete and reliable. It showed that during the last five years the number of cheese factories had increased 7 per cent, now aggregating 1,649 with 40 factories in addition, that make both cheese and butter. The creameries had diminished some in number, as many of them had been converted into skimming stations. At the time, there were 1,017 creameries and 260 skimming stations in the state.

The law for the licensing of stallions for public service having gone into effect January 1,1906. Dr. A. S. Alexander, upon whom devolved the duty of enforcing its requirements, organized and actively pursued the campaign for improvement of the horses of the state. Bulletin No. 141 of November 1906 from his pen gave a detailed account of the work accomplished and presented a list showing the name and address of each stallion owner, the name, age and exact breeding of his licensed horse, and whether it had been certified sound by a veterinarian or the owner's affidavit. The list disclosed the surprising fact that 1561 grade stallions and 4 cross-bred stallions had been licensed, along with but 1067 purebred stallions, showing a deplorable condition of affairs which certainly demonstrated the need of publicly advertising the exact breeding of each stallion offered for public service in, the state. Many fraudulent pedigree certificates had also been detected and rejected and the stallions represented by them given licenses as grades. The bulletin gave detailed information about many important phases of the horse-breeding business and submitted a proposed list of hereditary, transmissible or communicable diseases any one of which should subject a stallion to rejection as unsound. This was the first list of the sort proposed in America and it was hoped that it would be incorporated in amended or new legislation pertaining to the public use of stallions in Wisconsin. Many other improvements in the existing law were also proposed and to be asked for of the next legislature. The bulletin extended to 162 pages and was instructively illustrated. It aroused keen interest in Wisconsin and in many other states where horse-breeding was an important feature of the farming industry.

In Bulletin No. 143 of February 1907, Dr. H. L. Russell gave information about ~~no~~ the spread of tuberculosis through factory skim milk, and made suggestions as to its control. Tables giving the results of tuberculin tests on herds supplying different creameries accompanied the test. The tests had been made conjointly by the State Livestock Sanitary Board and the Experimental Station during the winter of 1906, and in ~~those~~ three cases showed conclusively that the spread of the disease was to be attributed to infected creamery skim milk. It is most commonly spread from farm to farm by "buying in" tuberculosis cattle that do not show apparent evidences of the disease. The use of hand separators was suggested as a means of avoiding danger from factory milk, but it would not insure immunity from one's own herd. Pasteurization of the skim milk was recommended as the only effective measure that would wholly eliminate the danger from that source. It could be done by the use of exhaust steam, or preferably live steam, and such pasteurization at a standard temperature of at least 176°F. should be made compulsory by law, the enforcement of such a law to be placed in the hands of the State Dairy and Food Commission.

Official tests of dairy cows, made in 1905-6, were reported in Bulletin No. 144, of January 1907, by Prof. Woll and Roy T. Harris. The report was profusely illustrated with portraits of some of the high producing cows, and tables gave the records made. It was stated that dairy breeders, and the dairy public in general, were showing a greater interest in the official tests year by year. The general rules under which the tests were conducted during

1906, were printed at the end of the end of the bulletin. During the year, 922 different tests had been conducted by the Station, compared with 864 tests during the season of 1904-1905, and 741 during 1903-1904.

Director Henry and D. H. Otis furnished another report in Bulletin No. 145 of January 1907, relative to the value of shelled corn and corn meal for fattening pigs. Experiments on that subject had been conducted for the past ten years, and the results published in the annual reports of the Station. In 1906-7 the tests had been conducted in three series, with results that corroborated information obtained in previous years.

Bulletin No. 146, of April 1907, by Prof. Whitson and E. R. Jones, presented an extensive report on the drainage conditions in Wisconsin. The investigations concluded that reclamation by drainage would make two million acres of peat and muck lands, in the central and northern districts of Wisconsin, fairly productive for farming purposes. Drainage of the marsh lands in the southeastern part of the State would make nearly two-thirds of a million acres as valuable as any lands in the State. The amount of claylands needing drainage, and the total benefits derived from such drainage, would be nearly twice as great as in the case of marsh lands. An accompanying table showed the acreage of poorly drained land of each type, together with the cost and profit of drainage. The writers stated that they know of no way in which so great an increase in the productive power of the agricultural lands of Wisconsin could be effected as ~~be~~ by drainage.

In Bulletin No. 147 of April 1907, E. J. Delwic~~k~~he, Superintendent of the Northern Sub-Stations, reported on the first season's work done there in 1906. The experimental work had been conducted under the direction of Professors R. A. Moore, E. P. Sandsten and A. R. Whitson, heads of the Departments of Agronomy, Horticulture, and Soils respectively. The Stations were located near Ashland, Iron River, Bayfield and Superior. The experiments were beg~~a~~un in the spring of 1906 and were reported briefly on in the 23rd Annual Report of the Experiment Station. The bulletin matter was arranged under the three heads of Agronomy, Horticulture and Soils. That on Agronomy included sections relative to crop growing experiments on sandy soils at Iron River and on clay soils at Ashland and Superior. The horticultural section dealt with orchard work on Madeline Island, the Bayfield Peninsula, and at the Douglas County Poor Farm near Itasca; also with potato experiments at Iron River, which included notes on spraying, and the Bordeau mixture. The experiments on sandy soils were conducted to test the effect of commercial fertilizers, both alone, and as a supplement to peat and barnyard manure; to establish a suitable crop rotation; and for the use of cash crops, both as substitutes for clover and as green manure. The results were, with corn and potatoes, that peat, in combination with rock phosphates, seemed effective as a substitute for barnyard manure; while acid phosphats apparently gave a decided increase in yield, as did lime carbonate, but not in any marked degree. Nitrogen and humus were found most needed on sandy soils. The season's experiments showed that, for use as green manure on sandy soils, cow pea, hairy vetch, soy bean and crimson clover best adapted. Many other phases of the work were also reported including results of experiments with tile drainage, rotation of crops, and with fertilizers for red clay soils, the growing of barley and oats, and the effect of tiling on corn.

The pasteurization and the inspection of creamery and cheese factory by-products were discussed by Prof. Farrington and E. G. Hastings in Bulletin No. 148, of April 1907. The subjects dealt with were: pasteurization of skim milk and whey; a storage tank for hot skim milk; delivery of hot skim milk; whole milk must be sweet for the successful pasteurization of skim milk; feeding value of pasteurized skim milk; amount of water added to skim milk by pasteurizing with steam; pasteurizing buttermilk and tests for pasteurizing milk and whey (Hastings):

Sugar beet experiments, conducted in 1906, were reported in Bulletin No. 150 of April, 1907, by Prof. Woll and C. W. Stoddard. An appendix presented tables showing the percent of sugar and the yield of beets, and of sugar in pounds, obtained on The Hill Farm of the Experiment Station, and at other farms in various districts of the State. Notes were also given on the effect of fertilizers on beets. The investigators had found that in all cases but one, the largest yields of beets and of sugar were obtained on plots receiving a complete fertilizer of nitrate, phosphate and potash. Farmyard manure produced the next highest yields, and was by far the cheapest fertilizer. Lime, applied at the rate of 1,000 lbs. per acre, produced a benificial effect on the yield obtained from two fields at Lancaster, on the Vernon County Asylum field, and on three fields at Chippewa Falls. On the heavy clay soil at the latter place, a double application of lime was necessary to increase the yield of beets and of sugar.

In Bulletin No. 151, of May, 1907 Prof. Wall gave information about condimental foods for livestock. His researches on the subject led him to conclude, jointly with other scientific men in public positions who had given the matter special study, that condimental stock foods are of no benefit to healthy animals, when fed as directed by the manufacturers, or as a cureall for diseases of the various classes of livestock. He had not found them to possess any particular merit for specific diseases, or for animals out of condition, off feed, etc. The bulk of the foods consisted of a "filler" which possessed no medicinal properties whatever. The prices charged for the foods were considered exorbitant. He concluded that "a net saving of at least a quarter of a million dollars would result to the state if our farmers discontinued the use of these foods, and would purchase in their stead similar amounts of standard concentrated feeds."

A comparison of aniline and analto butter colors in butter making was given by Prof. Farrington and Martin Meyers, in Bulletin No. 152, of June, 1907. They found by these tests that nearly twice as much vegetable color was needed in some cases to produce the same shade of color in butter, as was given by the aniline color. Butter makers who had been accustomed to using the weaker anatto color had, in some cases, added too much of the stronger aniline color, which accustomed the consumer to a more highly colored butter than previously obtained. As the natural color of June butter is sufficiently high, the addition of only enough vegetable color to produce that shade would prevent the danger of using so much as to impart a butter-color flavor. The vegetable colors impart a rather greenish-yellow shade to butter, which is quite different from the bright or reddish-yellow color imparted by this aniline colors. Some brands of vegetable color contained a decided flavor of the oil used in their preparation, which was distinctly noticeable in the butter when large quantities of such brands of color were used. Improvement noted in the strength and flavor of certain brands of vegetable butter color indicated that such colors, eventually, might compare favorably with the aniline butter colors. When butter was held in cold storage at 5 degrees below zero, neither the vegetable nor the aniline colored butter showed any indication of fading or changing color. It was concluded that butter can be satisfactorily colored with a vegetable color.

Research Work Reported in 1906-1907

The first research project summarized in the 24th annual report was that conducted by Messrs. Raitt and Rosenthal for a thesis submitted by them for the degree of Bachelor of Science in Agriculture in June 1907. It consisted of observations on sheep breeding made from records of the University flock. The summary was prepared by Prof. Humphrey and Frank Kleinheinz. From the breeding record of 240 ewes for a period of five years the investigators concluded that the normal gestation period of the ewe ranges from 145 to 151 days, with the greatest percentage of ewes lambing 147 days after service. Lambs born later than the 147th day sometimes were weak or born dead. The size of the lamb did not seem to be affected by the time it was carried *in utero*. Shropshire ewes were most prolific. Twin and triplet lambs were weaker than single lambs at birth. The percent of ram lambs increases and that of ewe lambs decreases as the age of the ewe advances. The size of the ewe and not that of the ram determines the size of the lamb. A ram is at his best at 2 and 3 years of age. The age of the ram has no effect on the sex of the offspring.

Based upon his investigations, including analyses of milk of the University dairy herd, Prof. Hart concluded that the relation of casein to fat in cow's milk is a variable one. One of the prime factors controlling its relation is individuality. The relation of casein to fat varies amoung animals of different breeds and among animals of the same breed. Direct determination of both fat and casein seems necessary in determining the value of the milk of any single cow for cheese production.

The Hart Casein Test

During the year, Prof. Hart also devised a simple mechanical method for the estimation of casein in cow's milk as a simple mechanical method, operative by the unskilled, and reasonably rapid was desired, resort to the centrifuge was made. The principles involved were: Construction of a tube and scale whereby percentages of casein in milk might readily be read; Establishment of a proper volume of milk to be used that will conform to the tube and scale adopted, allowing direct reading of the percentage of casein; The precipation of the casein by dilute acetic acid; ~~Afitation~~ agitation of the precipitate with chloroform to remove the fat; applicati~~ve~~on of a definite centrifugal force in order to mass the casein into a pellet, and reading the percent of casein. Later it was ~~ænounced~~ announced that the tube ~~desired~~ devised by Prof. Hart was very similar to one designed by Hovert and used in the analysis of saccharine products. Illustrations of the Hart tube and the centrifuge used in evolving the casein test accompanied the printed descriptions of the apparatus. Instructions for making the test were given. It was stated that the following preservatives vitiate the results: formalin, chloroform, toluol, and mercuric chloride. Experiments with potassium dichromate showed that in the proportion of one tablet to 300 cubic centimeters of milk, accurate and sharp results can be obtained where the preservative is in contact ninety-six hours or less. Above that time it is liable to make the casein pellets ragged and irregular. Composite milk samples made by consecutive twelve hour additions of small portions of milk to one-half tablet of potassium dichromate, as is the usual practice in accumulating milk samples for the Babcock test gave accurate results at the end of three and a half days. A longer time tended to make the reading ragged. In no case could coagulated milk be used for the test.

In making the Hart test 2 cubic centimeters of chloroform, fairly accurately measured, are placed in the tube and on top of the chloroform are added approximately 20 cubic centimeters of an 0.25 per cent solution of acetic acid at as nearly 70°F. as is practicable. Five cubic centimeters of milk, accurately measured are next placed in the tube at a temperature of 65 to 75°F. The contents of the tube are then thoroughly shaken for 15 to 20 seconds. The tubes are next placed in the centrifuge, the machine closed and after a speed of 2,000 revolutions a minute has been obtained, the test is run 7.5 to 8 minutes. After the tubes have been removed and stood upright for a time, the casein will rest a sharply defined white mass above the chloroform, which now holds the fat in solution, while above the casein will be a water clear solution of the other milk solids. The reading of the scale showing the percentage of casein should be made after the tubes have stood for at least 10 minutes.

Readings can easily be taken to half divisions or one-tenth of a per-cent, and with care and practice even to five-hundredth of a percent.

George A. Olson contributed to the 24th annual report a paper on the influence of metals on the action of rennet. Pure nickel caused the most striking retardation, and platinum and tin the most doubtful. The degree of influence of iron on milk, as in rusty cans, depended largely upon the temperature, the length of time, and the amount of surface. Milk kept over night in extremely old, rusty cans, when treated with rennet, would require from three to forty minutes longer to coagulate than milk kept in good cans.

Prof. Woll and George A. Olson also reported miscellaneous chemical analyses, including those of four-year old cheese made from milks of different fat contents, skim milk cheese; soybeans; salty milk; human milk; and factory by-products.

J. L. Sammis reported experiments conducted at the Station in cooperation with the Dairy Division of the U. S. Department of Agriculture, relative to the Chemistry of Milk Curdling. He found that the quantity of any acid required to coagulate a given sample of milk is less at a high temperature than at a low temperature; in alkaline milk, neutral salts affect the curdling temperature. The reaction of lime-water casein solution with acid, producing a milky white appearance, was shown to be strongly dependent on temperature. The reaction between milk constituents, acids, etc., in solution is reversible and the state of equilibrium amoung the dissolved substances is affected by changes of temperatures. Milk coagulates whenever the chemical attractions of curd constituents for each other, and of the whey constituents for each other, become relatively stronger than those which bind curd constituents and whey constituents together. This is based upon the view that chemical attractions hold all of the constituents of milk serum in union with each other.

Prof. Sammis further discussed the coagulating of fresh and alkaline milks in a second paper reporting the results of experiments conducted by him in cooperation with the Dairy Division of the U. S. Department of Agriculture. It dealt with the effect of neutral salts on the coagulation of sweet, fresh milk and milk containing caustic alkali. The tests made confirmed the conclusions reached in the preceding paper and rendered it very certain that milk curdling does not depend upon the neutralization of lime alone, but is a reaction in which all of the constituents of milk take part.

J. W. Moore, stationed at Madison by the Dairy Division of the U. S. Department of Agriculture, as expert cheese-maker, described and illustrated in the 24th annual report an automatic cheese press he had devised while working in cooperation with the dairy experts of the Wisconsin Experiment Station. It was a modification of the ordinary press, and was constructed to maintain automatically a constant pressure for any desired length of time. By insuring continuous pressure during the night, the cheese in the new press, were more perfectly closed than was otherwise possible. There was also less loss of fat, because a lower pressure was applied to the warm curd than is required by the ordinary press. Dr. Babcock, Dr. Sammis and George A. Olson made valuable suggestions which aided in perfecting the new, automatic press.

Prof. E. G. Hastings and Conrad Hoffmann made tests to determine the bacterial content of machine-drawn and hand-drawn milk and concluded that under correct conditions, with reference to the milking machine and other utensils, the cows and the amount of dust in the air of the stable, the use of the milking machine will produce milk with as low a germ content, or even lower, than that drawn by hand.

The results of the investigations of the cell elements in milk and their relation to sanitary standards, made by Dr. Russell and Conrad Hoffmann, and already mentioned in the section about work of the departments in 1906-1907, were the subject of a special paper in the 24th annual report. It was further stated temporary disturbances in the udder, which are really gargets of a physiological character, very soon disappear, and the milk becomes wholly normal, although the evidence of such slight inflammatory disturbances may continue for a considerable time. No adequate reason was found warranting the exclusion of milks of these animals from ordinary domestic supplies. The most that could be said of leucocyte examinations, thus far in the investigation, was that they are suggestive rather than final, and the investigators did not feel it wise, as yet, to formulate a quantitative standard to be used as a hard and fast one in the inspection of milk supplies.

Prof. Whitson, C. W. Stoddard, and A. F. McLeod contributed to the 24th annual report a second articlu on The Nitrogen Content of Soils, as Affected by Methods of Farming. The losses by denitrification and leaching were greatest on soils originally high in nitrogen content and averaged 29.6 per cent of that removed by crops, compared with 22.3 per cent noted in report of observations made in the previous year. It appeared likely that the nitrogen added in the form of manure, as ordinarily applied, does not accumulate in the soil, and it was deemed advisable that a very careful study of the methods of applying farmyard manure should be made, to determine whether it should be applied in very small quantities annally or in larger amounts at intervals of four to six years, as is the customary practice.

Following papers relative to the cranberry investigations and fertilizer experiments with sugar beets J. H. Milward reported observations upon the prevalence of early potato blight in Wisconsin. He had been making investigations on the subject for four years . The causal fungus, Alternaria solane, was illustrated and described. For its successful control it was advised that a correct understanding of its nature and life history and a clear correlation of these facts as associated with standard methods of control are imperative. A rational handling of the soil and selection of varieties, together with attention to the essentials in management in the use of applied remedies, is also necessary.

He followed with a report of the results obtained from spraying experiments conducted in 1907 at various potato growing centers in the State. Bordeaux mixture had proved an efficient preventive of early potato blight, where cultural conditions were suited to the crop. The most severe losses from blight had been observed where the soil had been exhausted either by continuous cropping or natural leeching.

Prof. J. G. Moore furnished a paper on the influence of "bottom heat" in forcing cucumbers. His experiments had shown that a soil temperature of approximately 74 degrees, gives greater fruitfulness during the same length of time, than temperatures ~~varying~~ ranging either much higher or much lower. Increases in temperature had little effect in increasing earliness in production, or flower production. Sunshine, atmospheric temperature and individuality of plants are the most important factors in flower production. The higher soil temperatures shorten the fruiting period of the plants and do not warrant additional cost in maintaining them above those which usually exist under ordinary forcing conditions employed in growing cucumbers. Better results can be obtained by using seed from the best individual plants, than be attempting to influence production by increased soil temperature.

Prof. J. G. Moore and A. J. Rogers in reporting on the tobacco work carried on by the Experiment Station during 1907, mentioned that nearly 300 lbs. of seed grown under direction of the Horticulture Department had been distributed among growers and that tobacco grown from this seed had been awarded the sweepstakes prize at the Wisconsin Tobacco Growers' Convention held at Madison in 1907. The seed was produced by tobacco grown from the improved strain of Wisconsin-grown Connecticut-Havanna seed, similar to that previously distributed by the Station. The Station did not intend to continue destributing tobacco seed but informed all growers who received seed in 1907 to save their own seed for use the following season.

Superintendent E. J. Delwicke of the Northern sub-stations and Prof. J. G. Moore presented a paper on the relation of orchard cover crops to soil moisture and soil freezing as to ease in getting a catch they found oats, rape, ripe and mellet to sant first [redacted]; cow pease, turnip and Canada field peas, second; and soybean, crimson clover and hairy vetch, third. The relative value of these crops in obtaining an early cover, standing drought, resistance to shade, resistance to attacks of fungi, efficiency in converving moisture content and holding snow, and ability to resist frost and stand trampling was also set forth.

Prof. R. A. Moore and A. L. Stone reported on experiments with grain and forage plants, barley smut investigations, and eradication of farm weeds (with George Hutton). Brewing barleys were discussed by C. P. Norgord and tests with grains and forage plants at the northern sub-stations by Moore and Delwicke. Sixty-Day and Kherson oats had given the largest yields at the Experiment Station. Oderbruchin and Mansury barley proved most satisfactory. Seltir King and Golden Glow were widely disseminated and grown and Early Yellow Dent and Smut Nose Flint corn tried out. Results with Oderbruchin barley were then considered satisfactory, altho the season had been unfavorable. About 100 farmers in the northern counties cooperated with the Station in testing standard grains. The trials made were with Oderbruchin barley, Swedish select oats, and Wisconsin No. 8 corn.

It was found that loose smut of barley can be evadicated by the modified hot water method of teating seed. About 7 percent of the barley grown in Wisconsin was found affected with smut.

For brewing purposes, the barleys giving the best satisfaction were Svanbals, Chevalier, Princess and Primus.

A list of 40 other varieties of barley was also made at the Station.

The Twenty-Fourth Annual Report of the Wisconsin Agricultural Experiment Station, for the fiscal year ending June 30, 1907, which has been reveiwed in the foregoing section of this history, was the last published under the administration of Professor William Arnon Henry, at the conclusion of his twenty seven years of imminent service and accomplishment as Director.

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