Dr. W. E. Johnson, President,
South Dakota State College,
Brookings, South Dakota.

Dear Sir:

As director I have the honor to make the following report of the South Dakota Agricultural Experiment Station for the fiscal year ending June 30, 1922:

Organization

This experiment station was organized under the provisions of the Hatch Act of 1897 and the Adams Act of 1906. These were acts of Congress which gave to each state in the Union $30,000 annually, the same to be expended under the supervision of the Secretary of Agriculture. The legislature of South Dakota accepted the conditions and made the station a part of the South Dakota Agricultural College.

Object

The object of the station is to conduct experiments and investigations along agricultural lines for the benefit of the producers of the state.

Staff and Work

Station Staff—
J. O. Johnson ..........................................................Regent Member
T. W. Dwight ..........................................................Regent Member
Willis E. Johnson .....................................................President of College
James W. Wilson ......................................................Director and Animal Husbandman
N. E. Hansen ..........................................................Vice-Director and Horticulturist
A. N. Hume ..........................................................Agronomist and Supt. of Substations
Harry C. Severin ......................................................Entomologist
B. A. Dunbar ..........................................................Chemist
J. G. Hutton ..........................................................Associate Agronomist, Soil Survey
Arthur T. Evans ......................................................Associate Agronomist, Crop Pathologist
Alfred Bushey .........................................................Agronomy Analyst
Matthew Fowlds ......................................................Assistant Agronomist, Seed Analyst
Arthur H. Kuhlman ...................................................Associate Animal Husbandman
T. H. Wright, Jr. ......................................................Assistant Dairy Husbandman
Thomas M. Olson .....................................................Assistant Dairy Husbandman
George Gilbertson ....................................................Assistant Entomologist
The station funds are used to pay salaries of men in proportion to time given to the work. Before the beginning of each fiscal year inquiry is made of each head of department to ascertain the experiments to be conducted, time to be occupied, about how much money will be needed, and the projects outlined. It is our policy to confine the work to as few departments as possible, believing that more and better results will be secured from a few departments well supported than from many departments poorly supported.

At the present time there are six divisions, as follows:—

Agronomy
Animal Husbandry
Chemistry
Dairy Husbandry
Entomology
Horticulture

About two-thirds of the entire appropriation is expended for salaries and labor. Believe we are doing as much for funds received as workers at any other station in the Northwest.

State Appropriations

The legislature of South Dakota makes an appropriation of $1,500 annually for the printing of popular bulletins and a small appropriation for the maintenance of the four substations at Eureka, Cottonwood, Highmore and Vivian. The soil and climatic conditions at these substations are not the same, hence the production of grain crops and rotations are the principal lines of work considered. Sometime when support can be secured it might be well to work in other lines, but for the present funds will not permit expansion.

Publications

There were seven bulletins printed during the fiscal year on the following subjects:

194 Acme Wheat.
195 Feeding Dairy Cattle.
196 Potatoes in South Dakota.
197 Milk Testing in Practice.
198 Influence of Purebred Dairy Sires.
199 Sunflower Silage for Steers—Smuted Corn Silage for Pregnant Cows.
A mailing list of several thousand in the state is maintained and when two or more bulletins are printed they are mailed to this list. Much difficulty is experienced in having bulletins printed and for this reason the most efficient distribution has not been possible. For example: Agronomy bulletins would be of much more value if they could be distributed in winter before time of seeding. Thirty thousand copies are printed of the more popular bulletins and less of others.

Many requests for bulletins are received not only from residents of South Dakota but people of other states and foreign countries. Frequently requests are received from professors of educational institutions in other states for a supply for class work. The teachers in high schools in the state use our bulletins to an extent as texts. In this connection there is an increasing demand for a bulletin on the weeds of the state similar to No. 150, the edition of which is entirely exhausted. There are other bulletins of this station that should be reprinted, but the cost of doing this is prohibitory on account of limited station funds. Other states have funds from the state for reprints, why not South Dakota?
DEPARTMENT OF ANIMAL HUSBANDRY

In the Department of Animal Husbandry experiments were conducted in cattle feeding, swine feeding, and sheep breeding.

Cattle Feeding

For several years we have been conducting experiments in feeding cattle to determine the value of corn silage in beef making. To secure similar information as to the value of sunflower silage was the object of this experiment. Sunflower silage was fed last year and this year to different aged cattle, yearling steers were used for experiment this year, without a supplement. Probably better gains would have been received had we added a supplement such as oilmeal or cottonseed meal, but to determine its feeding value to corn silage we fed a lot on corn silage as a check. Results of experiments in feeding the corn silage alone have been good and knowing the tendency to feed the sunflower silage, probably as the sole ration, we considered this feature valuable.

The steers receiving corn silage, when on full feed, were eating about twice as much silage as steers receiving the sunflower silage, indicating that the sunflower silage was not as palatable a feed as the corn silage. Three other lots of steers were used to determine whether it would be an advantage to mix the sunflower silage with the corn silage. The results show that the average gain for each lot fed in this manner is in proportion to the amount of corn silage in the mixture. Results of this experiment are reported in detail in Bulletin No. 199.

Another experiment in feeding cattle was conducted in feeding corn smut to cows. The comparatively large quantity of smut on the corn plant during the summer and fall of 1921 caused considerable uneasiness among the owners of silos in many sections of the state as to what effect the feeding of smutted silage would have on cattle and especially on the pregnant cow. Because of this condition we were informed that some silos were not filled. To furnish information along this line an experiment was planned. Two barrels were filled with corn plants on which ears were growing that were partially or all smut. These stalks and ears were cut with a hand cutter into small pieces and packed into the barrels. This furnished a feed that contained a larger percent of smut than is ever found in a cornfield. A third barrel was filled with ears that were
badly smutted. The results of this experiment are also reported in detail in Bulletin No. 199.

Swine Feeding

To what extent can tankage in a ration for feeding pigs be supplemented with rape pasture? Can barley be fed to fattening pigs successfully, and if so, is as much tankage required as for corn? These questions will be considered further before publishing results.

Sheep Breeding

For several years we have been conducting an experiment with sheep. The object of this experiment is to develop, if possible, a harder breed of sheep than any we now have, to eliminate the tail so lambs will not require docking, and to square up the rump. The Siberian fat rump breed imported by Dr. N. E. Hansen on his last trip to Siberia is being used.

The following financial statement is furnished by Mr. R. A. Larson, secretary of the Station:
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- **Popular Bulletin Expended**: $1,499.20
- **Popular Bulletin Reverted**: $5,811.43
- **Balance on Hand Experiment Substation July 1, 1922**: $1,225.17
- **Balance on Hand Station Local, Home Station, July 1, 1922**: $59,968.87

**Subtotal**: **$1,499.20**
For a more detailed statement of the work of this Station, I include and make a part of this report the report of each chief of division.

Yours truly,

JAMES W. WILSON,
Director of South Dakota Agricultural Experiment Station and Professor of Animal Husbandry.
DEPARTMENT OF AGRONOMY

Director J. W. Wilson, 
College.

Dear Sir:

Permit me to make reply in regard to the progress of Hatch and Adams projects and other experimental work of the year just closed.

ADAMS PROJECT NO. 1

A Project on the Influence of Rotation upon the Maintenance of Soil Fertility.

Included in the experimental field tests concerned in this project are two small fields of one acre each on East Farm, Brookings. Each of the one-acre fields is devoted to a crop rotation of its own, and also each field is divided into one-tenth acre plots. In addition to the rotation factor carried through on each set of plots, a complete fertility test is also comprised over the ten plots of each series.

According to plan, soil samples are taken from each of the several tenth-acre plots each seven-year period. Two sets of samples have been taken at the present date and also complete analyses for several elements have been carried through on both these sets of samples. The analyses for these samples taken in 1915 have been completed within the fiscal year since making the previous annual report. These analyses were accomplished by Messrs. Hutton, Bushey and Machlis, with occasional part-time assistants.

A perusal of the results secured indicates some soil changes brought about by differences in cropping conditions carried on for the length of time of this research. Crop yields from the several plots are preserved. It is noteworthy that all plots which have received applications of phosphorus either alone or in combination with nitrogen or potassium or both have produced increased yields over the check plots. This serves as an indication that phosphorus is the limiting element in the soil of the plots. An increase of slightly over thirty percent in the average yield of cereals has been produced on the phosphorus plots.

Likewise under this same project are included several continuous legume plots on the West Farm. Said plots have not been changed within the year. The principal problem in connection with said plots is to determine whether
continuous legume cropping with annual harvesting and taking away of hay will or will not diminish the total nitrogen content of the soil of the plots.

ADAMS PROJECT NO. 2

A Study of Correlations Between Certain Physical Characters of Plants and Their Capacity for Yield.

Experiment Station Bulletin No. 187 was report of conclusions from an earlier part of the present project. The bulletin mentioned gives results from experiments with head-rows of blue stem (Minn. 169) wheat. The head-rows were planted alternately with long mother heads and short mother heads of wheat. The conclusion reached after five years was that although slight increases in yield may be produced in wheat by selecting relatively longer mother heads, the slight apparent increase disappears after the first generation after selection.

At present writing we have completed similar correlation tables with head-rows produced in 1920 and 1921, and also in 1921 from original mother plants that were cultivated in 1919. Our results are now being prepared for publication in bulletin form and will include the head-row yields of the present season. The indications from correlation tables so far calculated are that the results with Marquis wheat are similar to results previously secured with blue stem. There is a slight correlation between higher yield and greater length of spikes used as mother heads for the first generation. This correlation, however, disappears in the succeeding generation which has now been calculated. The yields of the present season will add reliable data inasmuch as cropping conditions are very favorable at the present time. The head-rows in the crop breeding nursery are in charge of Mr. Fowlds, Dr. Evans, and Mr. Janssen.

The present project bears directly on the practical possibility of securing increased yields of cereals by selecting relatively long and fine appearing heads of wheat for propagation. Likewise it deals with a phase of the scientific question whether one can secure permanent variations within a pure line.

In the previous annual report the question was put down along with the present project, "Is Marquis a pure line?" At present it is possible to say that at least in one or two respects it behaves like one.
ADAMS PROJECT NO. 4

A Project to Determine Definitely the Effects of Phosphorus in Different Forms on the Growth of Plants and the Effect of Sulphur in Combination with Calcium (Gypsum, Calcium Sulphate), and as Pure Sulphur on the Growth of Plants and Its Effect—The Availability of Phosphorus in Different Forms.

This project calls for a large number of chemical determinations, especially phosphorus, as indicated by the original plan. Soils in special pots have been carried through differential treatments and a series of analyses well nigh completed. It seems not desirable to attempt to summarize results in a short statement, until analyses can all be tabulated. The indications are that the several treatments will yield consistent variations in the amounts of available phosphorus of the several pots. The project is being carried through in detail by Professor J. G. Hutton, with some special assistance at present by Mr. Biggar and Mr. Brown.

HATCH PROJECTS

Variety testing of cereals (corn, wheat, rye, oats, barley) and potatoes, alfalfa, soybeans and clover is in part continued under the present head. About five acres on East and West farms at Brookings are occupied by this kind of tests which form what may be called trial grounds. It is realized that these trials should be more than miscellaneous observations. Effort is made to have them be continuous with or basic to the several research studies conducted on Adams and other funds.

Among winter wheat varieties tested are three separate strains of Kanred. These are compared in yield with strains of Turkey and Kharkof which until the past 2 years have stood as the pre-eminent winter wheats for South Dakota conditions. These have been now outyielded 2 years at Brookings and 3 years at Highmore substation.

Marquis has been the most prominent spring wheat. In recent years it has rusted badly. Kota, Kitchener, Red Bobs, Ruby, and other varieties have been introduced in the hope that some of them would be at once as good yielders and more rust resistant. Ruby is an earlier maturing wheat than many of the others, which may account in part for the fact that it escapes rust.
What Is Rust Resistance?

It is true that rust epidemics may not be obviated entirely by importing new varieties, and the making of introductions is not all of science. Up to date the chief encouragement toward obviating rust epidemics has been to find varieties that were immune. Further study of such varieties may result in finding the factors of rust resistance in a bread wheat of high milling quality.

The continuity of experimental work was brought out by the 19 continuous year tests of varieties of oats at Highmore and at Brookings. The average yield of Sixty Day oats at Brookings as an average of 19 years has been 37.9 bushels. The average yield of Swedish Select—the next highest yielding variety tested for that length of time was 31.7 bushels. Note that Sixty Day outyielded Swedish Select on the 19 year basis by 6.2 bushels per acre.

Swedish Select could be shown to outyield Sixty Day on a basis of only the years 1916-1921. Six years is a considerable time, but it is evidently not long enough to establish results with variety tests of oats in the field—securing dependable information is a continuous process. The average yield of Sixty Day oats at Brookings for 19 years was 55.4 bushels, and of Swedish Select was 43.6 bushels, 11.8 bushels higher yield for the Sixty Day.

At Brookings a livestock system of cropping is under comparison with a grain system of cropping. The plots on West Farm on which these systems are conducted were examined. Professor Hutton reported that as an average of 7 years, the livestock system (where manure is returned) yielded 40.8 bushels of corn and 63.8 bushels of oats per acre. The grain system (where crop residues are returned and no manure) yielded an average of 43.7 bushels of corn and 71.6 bushels of oats per acre. Thus the total average yield of grain has been greater from the grain system where the crop residues rather than manure were applied.

In addition to making introductions from Canada and other states, a number of plant selections are being made by Dr. Evans, Mr. Fowlds and Mr. Janssen. These plant selections are tested out in head-rows and later are put into rod-rows and increase plots, providing they give evidence of merit. The Cole oat was such a selection and the Acme wheat. Other and newer selections are coming on. Our cereal breeding nursery, consisting of a thousand head-rows is made possible at Brookings by Hatch funds. Similar nursery work is carried on at Highmore substation.
Other specialties being developed is Fowlds Hulless oat, which is now increased to one-fourth acre, from the original plant. It is possible this Fowlds Hulless oat will prove to be the best yilder of its kind in South Dakota—it bids fair at present. It will be a choice feed for young stock especially young pigs; a natural substitute for oatmeal.

**Corn Breeding**

Corn breeding studies are continued. We are studying the correlation between protein content in corn and yield of protein per acre.

The writer is continuing a system of corn breeding devised by himself, wherein we hope to secure (1) continuous selection, (2) hybridization, and (3) introduction of new strains or the closest approximation that can be arrived at with a wind-pollinated monoecious plant. Perhaps the same system of breeding may prove serviceable in breeding gregarious animals. We are studying the system as such.

May we call attention to the fact that increases in crop yields and consequent cheapening of food for man and livestock, depends on information. Information comes from experimentation, agriculturally, and otherwise. This fact has been emphasized since the time of Roger Bacon; and acted upon haltingly.

The business of farming needs more information of the kind it gets for itself through experimental evidence. This is true in production and in economics, which are not far apart.

Agronomy could use more land for nursery experiments with cereals and forage crops, and for testing high yielding and rust resistant varieties of cereals and forage crops. We could enlarge our rotation experiments and experiments in weed eradication, and especially our forage crop experiments. Such an increase of experimental area would call for increased funds in proportion to the amount of increase in experimental work. Our efficiency in getting information about soils and crops would be increased by our having more greenhouse space for soil and crop cultures and crop breeding. In connection we should need enlarged laboratory space and additionally technically prepared workers.

The needs of Agronomy are mentioned even in view of the present serious economic condition of farming as a business. Indeed they are mentioned partly because of that fact. If agriculture and those who represent it fail to call attention to its needs, they may fail of getting attention, due
to the very urgency of the times. Additional funds for Agronomy, whether $5,000 per year or more, would facilitate the work of getting knowledge about soils and crops in South Dakota. The basis of farming is knowledge.

The following bulletins have been published during the fiscal year just past:

No. 194 Acme Wheat.
No. 196 Potatoes in South Dakota.

Very respectfully,

A. N. HUME,
Agronomist and Supt. of Substations.
My dear Sir:

In reply to your letter of July tenth, I submit herewith a brief report of the experiment station work carried on by the Entomology department during the fiscal year ending June 30, 1922. Two projects were actively prosecuted during the year and both of these were financed through Adams funds. Adams Project 3 was conducted under the leadership of H. C. Severin, while Adams Project 4 was carried on under the leadership of George Gilbertson.

Adams Project 3

Title: Distribution, life history, economic importance, natural enemies and control of the common field cricket (Gryllus assimilis Fab.).

During the past year we directed our efforts chiefly to a study of the life history of this injurious insect under both field and insectary conditions. We found that this insect passes through an unusually large number of molts. A complete description of each instar has been written up and the duration of each instar recorded. Some variation was found to exist in the number of molts that different individuals passed through and likewise considerable variation was found in the size and coloration of body parts of different specimens.

The behavior of this species of cricket was studied in the field and much additional data was gathered on this phase of the work. The materials that crickets use as food was further investigated. The egg-laying activities of the pest were studied and we now have full data upon the number of eggs that are laid, the methods followed in oviposition, etc. We also have completed our data on the hibernation methods of this species of cricket. In addition we have completed our studies of the hatching processes, of the egg, the emergence activities of the nymph from the vitelline membrane and the molting processes.

Additional data was obtained regarding the natural enemies of the field cricket. To date we have found the following parasites attacking the eggs, nymphs or adult crickets:
Ceratoteleia marlatti Ashmead. Hymenopterous egg parasite.
Paradris brevipennis Fouts. Hymenopterous egg parasite.
Exoristoides johnsoni Coq. Dipterous parasite of nymphs and adults.
Enthrombidium sp? Mite parasitic upon adult cricket.
Gamasidae sp? Mite parasitic upon adult cricket.
Paragordius varius Thread worm parasitic within nymphs and adults.
Chlorion cyanium Dahlborn Wasp enemy predaceous upon nymphs and adults.
Zelotes sp? Spider predaceous upon nymphs.
Phidippus insolens sp? Spider predaceous upon nymphs.

We have made additional observation on the injury done by the field cricket. This entailed considerable time and necessitated cooperation with the Agronomy department of the College from the identification of many plants.

No new methods of control can be recommended outside of those discussed in my annual report for the fiscal year closing June 30, 1920. Experiments are now in progress to control the cricket pests with various poisoned baits. It is as yet too early to draw any definite conclusions from these experiments.

**Adams Project 4**

Title: The wheat stem maggot (Meromyza americana Fitch), its distribution, food plants, economic importance, life history, habits, natural enemies and control.

The bibliographic work has been carried on very near to completion. We now have access to the bulk of the publications dealing with this insect.

Various lines of life history work dealing with this pest have engaged our attention during the past fiscal year. Owing to the peculiar weather conditions prevailing during the summer of 1921, the life cycle of the wheat stem maggot was somewhat modified from what it is during ordinary years. This modification manifested itself in the following manner: 1st, the various stages appeared earlier than usual; 2nd, the stages were shortened; 3rd, there was an apparent aestivation during the dry weather to meet the drought conditions.
The life history work included rearing of the pest through all of its generations during the year. Through this means we have again had an opportunity of checking up with our findings of former years. The following important phases of the life history work were emphasized during the past year: (a) first appearance of adults; (b) maximum appearance of adults; (c) longevity of adults; (d) mating; (e) preoviposition period; (f) egg-laying habits; (g) description of eggs; (h) number of eggs laid; (i) duration of egg stage; (j) hatching of egg; (k) description of larval stages; (l) feeding habits of larvae; (m) host plants of larvae; (n) pupation; (o) description and position of pupa; (p) duration of pupal period; (q) emergence of fly from pupa.

The brood curves of last year compare very favorably with the curves of former years. There are three broods in the region of Brookings, the bulk of the flies appearing from late May to early in June, from July 4 to August 10 and from the last of August through September. Overlapping of broods occurs yet through systematic daily collections of flies and through breeding work and field studies the plotting of the brood curves may be readily accomplished.

During the past year the amount of injury done by this pest was again determined. It was found that the year was an average one and that the amount of injury did not vary from that done in ordinary years.

The distribution of this pest in South Dakota has been more thoroughly determined and the host index enlarged. The varieties of wheat found infested last year and not reported infested in our last report were as follows:

- Black Don
- Monad
- Pellis
- Mindum
- Arnautka
- Pierson 999
- Redrock
- Disco
- Kanred
- Kitchener
- Redbob
- Ruby
- Station Red

We have also added some new varieties of barleys and new species of native grasses to our list of plants susceptible to injury from the wheat stem maggot.

The past year has given us more of an insight into the life history and importance of the parasites working upon the wheat stem maggot. These parasites are the following:
1. Microbracon meromyza Gah.
2. Coeliiidea meromyza Forbes.
3. Pediculoides ventricosus.
4. Trombidium sp.
5. Fungus sp?

The hymenopterous parasites (Microbracon meromyza and Coeliiidea meromyza Forbes) are by far the most important. The larvae of these forms are parasitic upon the wheat stem maggot. Of the mites, the Pediculoides is parasitic upon the maggot, while the Trombidium attacks the adult fly.

During the past year, 1741 wheat stems infested with the wheat stem maggot were collected and placed in breeding cages. From these stems we reared the following insects:

<table>
<thead>
<tr>
<th>Insect</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meromyza americana males</td>
<td>201</td>
<td></td>
</tr>
<tr>
<td>Meromyza americana females</td>
<td></td>
<td>249</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microbracon meromyza Gah.</td>
<td></td>
<td>61</td>
</tr>
<tr>
<td>Coeliiidea meromyza Forbes</td>
<td></td>
<td>65</td>
</tr>
</tbody>
</table>

It is apparent that most of the stems yielded neither flies nor Hymenopterous parasites.

During the past year we have attempted to determine the effect of various cultural and crop rotation methods upon the wheat stem maggot. Control through poisoned baits was again attempted and while many baits were tried and most of them found ineffective, a few promising ones are listed for further explanation. Light traps have proven futile, as has also hand picking over large or even small areas.

Drawings illustrating the life history of the wheat stem maggot have been prepared. Photographs showing the injury done have also been made.

**More Funds Needed**

There is an immense monetary loss to the citizens of South Dakota from the work of various species of insects. I append a list of projects which are very important from an economic entomological aspect and which it would be advisable to take up as Experiment Station projects:

1. An investigation of the life cycle and control measures applicable to all the various species of cutworms injurious in South Dakota.
2. An investigation of the complete life cycle of blister beetles and their control.

3. A determination of the life cycle of ox warbles and their control.


5. A determination of species of insects injurious to stored grains, their life cycle, cause for fluctuation in numbers, and control.

6. A study of the life cycle of the ash tree borer with methods of control.

7. A study of the mosquito problem in South Dakota, the species concerned, the life cycle and control.

A very important subject of investigation and one which I strongly recommend as an Adams project for approval is the following:

Title: A determination of the most important internal worm parasites of poultry in South Dakota, a study of the prevalent means of poultry infection and practical means of the worm control.

In this connection I wish to call your attention to the fact that the poultry industry is one of the most important industries in the state and that the internal worm parasites of poultry constitute one of the most serious drawbacks to this industry. Should this project be approved, it would necessitate cooperative work between the Zoology-Entomology department and the Poultry and Veterinary departments of the College. Only a small budget would be necessary to carry on this work, for the Poultry department has agreed to furnish us with most of the materials that we would need in this project.

Yours respectfully,

H. C. SEVERIN,
Entomologist.
DEPARTMENT OF HORTICULTURE

Director James W. Wilson,
South Dakota Agricultural Experiment Station,
Brookings, South Dakota.

Dear Sir:

In reply to your inquiry, I have the honor to present the following:

I. The breeding of hardy fruits is the only project on the Adams fund. The chief endeavor has been to determine the true nature of hardiness against winter cold and to originate new varieties combining winter hardness of plant with large size and choice quality of fruit. So far I have had the best results with the native fruits and their hybrids with the tame fruits, especially in the case of the plum, sandcherry, apple, gooseberry, raspberry, strawberry and grape. In apples and pears, very promising results have been obtained with Russian and Siberian material. The past season, a lot of splendid hybrids of the wild grape of North Dakota with the choice table grapes fruited heavily and were exhibited at the South Dakota State Fair. Of these fruits, many new varieties have been originated and disseminated, as described in the annual reports. I have made eight tours to Canada in the past four years to gather material, especially in Manitoba and Saskatchewan. In the apple, much work has been done in taming the American wild crab apple of Minnesota. Four varieties were distributed in the spring of 1922 for the first time, the Kola, Tipi, Shoko, and Zapta, hybrids of the native wild crab apple of Elk River, Minnesota, with standard cultivated varieties. The heaviest specimen of Kola in 1919 weighed three ounces and was two and one-half inches in diameter. This was the first year of fruiting. The fruit cooks up into acceptable sauce. I believe these crab apples will prove hardy far north into Manitoba and will keep well into spring in an ordinary cellar. In the standard fruit lists for the northern limits of apple culture in the prairie Northwest we must admit we have only summer and fall varieties, but no real winter apples that will keep into spring in an ordinary cellar. I believe that the future ideal winter apple must probably come about by a totally new combination of unit characters. The Russian apples and Siberian crabs are being crossed with standard apples. Of this series, four varieties were sent out last spring for the first time, the Goldo and Oxba apple and the Linda Sweet and Maga crab. I am
also trying to develop the pure Siberian crab, Pyrus baccata, as a late keeper by straight selection. The Beauty crab is one of the best of this series. This was first sent out in the spring of 1919 and additional trees were sent out the past spring, 1922. Some remarkable results have been obtained in these new seedlings in the way of early bearing. A 1 year old tree of my Anoka apple transplanted in the spring of 1920 bore 26 large apples in 1922, the second year after planting. This idea of a smaller tree and earlier bearing will be followed up as rapidly as possible. Such trees are easier to spray and the planters will not have to wait so long for the fruit. Various forms of Siberian crab apples are being tested extensively as a budding stock for the apple with excellent results so far.

Many pears have been tested at this Station. The outstanding survivors are a form of Sand pear, Pyrus Sinensis, imported from Russia. These are strongly resistant to blight. New hybrids with standard pears are coming on. The most remarkable of the Siberian pears is Pyrus Ussuriensis as received from north of Vladivostock. These trees are strongly resistant to blight. The same species from Liaoyong, Manchuria, does not stand the winter. The pathway to a series of hardy blight-proof pears with fruit of choice quality and large size is very clear to me at the present time.

In plums, I have heard from nurserymen that at present nine-tenths of the plum trees planted in the prairie Northwest are the Hansen Hybrid plums. The best of 10,000 seedlings is the Waneta, a two-inch, two-ounce plum, a hybrid of the America, a large Japanese plum, with pollen of the Terry, the largest native plum. Of the more recent seedlings, the Ojibwa, Pembina and Cree are the most promising, all hybrids of the native Manitoba plum with the Japanese plum.

II. On the Hatch fund, the main project is the breeding of hardy roses that will combine winter hardiness with the size and beauty of the cultivated roses. I am working extensively with Siberian and native material and many promising seedlings have appeared in the plantations. Thousands of blossoms are pollinated every year in this work. I think the work will give a clearer idea of the true nature of winter hardiness.

Our work with the Siberian crab apples has given us some interesting plants of value for ornamental planting. The Hopa Red Flowered Crab, offered for the first time in the spring of 1920, is a promising addition to our list of
ornamental trees for the lawn, owing to its wealth of beautiful deep rose crimson blossoms. It is attracting considerable attention as something of great promise as an ornamental lawn tree.

III. There have been no changes in the staff and no new buildings, but we hope to get some aid from the legislature this coming winter. We need a larger greenhouse and storage cellar, and especially do we need more land. During the past two seasons, the Regents of Education have kindly granted 15 acres of land to provide room for the many thousands of new seedlings.

IV. An endeavor will be made to secure from the legislature this coming winter additional land for horticultural substation work, also an appropriation for operating expenses. Many thousands of new seedlings are coming on and provision should be made for the necessary extension of the work.

Yours truly,

N. E. HANSEN,
Horticulturist.
Dear Sir:

Pursuant to your request of recent date, I would submit the following brief report of the work of the Chemistry Division for the fiscal year ending June 30, 1922:

The work of this division has been of a cooperative nature entirely. It has consisted of work along the lines of analytical aid to the projects of other divisions of the station as follows:

1. We have cooperated with the Division of Animal Husbandry in the analysis of silage. Report of our findings will form a part of the report of project having to do with this subject, and under the annual summary of the work of the above division.

2. In cooperation with the Dairy Division and particularly working in conjunction with Professor Olson of that division, we have done much laboratory analytical work and stable manipulation having to do with the Adams project now running under the title: "Relative Value of Proteins of Different Feeds in Dairy Cows' Rations." About one-third of the total work of the chemical laboratory of this division has been applied to the problems arising out of this project. Our results are embodied in the report upon the above project as submitted by the Dairy Division.

As per your further request, I would suggest the following as fit projects for our own division and would urge that we be assigned one of them for the coming year's work of the chemistry division:

1. We have proved, in connection with certain work in which we were cooperating with the Animal Husbandry Department, that the sulphur of wool is present in two forms of combination, probably both organic and inorganic. We wish to differentiate these forms, for the benefit of the dye industry and for the information of wool producers. The work will require no increase in our maintenance fund. Its extra cost will be met by allowance for salary of the analyzing chemist as now arranged under the Hatch Act.

2. We have received approval of the authorities at Washington, through Mr. Allen, of the following project,
which is in accord and will aid in solving a similar problem being carried on in the Maryland Station: We wish to work toward the determination of plant ash through an examination of growth-promoting media, so hoping to show error in our present methods of ash determination and also to determine the maximum growth of plants with minimum administration of plant food. Such a project would also be amply covered by present maintenance funds and would take about one-third of the time covered by salary under the Hatch Act, as now assigned us. I prefer this project above the others mentioned.

3. The annual type of sweet clover seed has not been examined for its constants. We suggest as a suitable project such investigation, as an aid in determining how widely such plant can be used as forage food, and to find whether it may not be valuable for other trade purposes.

4. In this state we have not, as have most other states, any means of determining whether waters submitted for analysis are above or below the norm in regard to chlorine content. I urge the need of a survey of the surface and deeper waters of the state, in order to determine the location of isochlor lines. Such work would require an appropriation of from $2,000 to $3,000 for its inception. If the state will aid the station work, such a project we would urge as a very proper one for the application of such funds.

In conclusion, I would once more urge the propriety of the establishment in near relation to the station here, of a Bureau of General Analysis, in order to relieve our station analyst for the proper work of the station, and that our friends over the state may have a place where they may apply for the general types of analysis which our chemist, under his part time as a college employee, has had to undertake. Such a bureau would not interfere with the work of the State Food and Drug Laboratory, but would rather relieve it of much work that is not its proper type of work to do, and make it possible to serve the people of the state more promptly and more efficiently than we can now serve them.

Follows a summary of the receipts and expenditures of this division:
<table>
<thead>
<tr>
<th>Receipts:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>For maintenance—Hatch Fund</td>
<td>$ 600.00</td>
</tr>
<tr>
<td>For salary—B. A. Dunbar—Hatch Fund</td>
<td>$ 266.66</td>
</tr>
<tr>
<td>For salary—C. F. Wells—Hatch Fund</td>
<td>$ 433.32</td>
</tr>
<tr>
<td>For salary—C. F. Wells—Adams Fund</td>
<td>$ 650.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$1,949.98</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expenditures:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>For maintenance—Hatch Fund</td>
<td>$ 595.76</td>
</tr>
<tr>
<td>For salary—B. A. Dunbar—Hatch Fund</td>
<td>$ 266.66</td>
</tr>
<tr>
<td>For salary—C. F. Wells—Hatch Fund</td>
<td>$ 433.32</td>
</tr>
<tr>
<td>For salary—C. F. Wells—Adams Fund</td>
<td>$ 650.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$1,945.74</strong></td>
</tr>
</tbody>
</table>

Respectfully submitted,

B. A. DUNBAR,
Chemist.
In compliance with your request I herewith beg leave to report concerning the experimental work of the Dairy Husbandry Department for the fiscal year ending June 30, 1922, as follows:

**Adams Project 1**

Title: Protein from Skimmilk versus Protein from Oilmeal and Peanut Meal for the Growth of Cattle.

It is now a well established fact that the chemical analysis of feeds is not an absolute determination of the feeding value of such feeds. Two feeds of practically the same chemical analysis may vary in their nutritional value.

The purpose of this project is to ascertain the difference, if any, in the nutritional value of the protein found in skimmilk when compared with the proteins present in oilmeal and peanut meal. This comparison was made because previous data from experimental work in this department is available whereby this comparison can be made.

The ration for all of the calves consisted of the following feeds: Oat straw, alfalfa hay, cornmeal, skimmilk, starch and salt. The protein of this ration was fed on a high and low intake. The low protein ration to supply little more than the minimum amount theoretically required, while the high protein ration supplied about the amount demanded by current feeding standards. The net-energy supply was equal for all calves.

The comparison of the calves was made on the basis of growth and increase in weight. Any physical factors which might be of value in ascertaining the nutritional value of proteins from different sources was noted.

The calves were weighed and measured bi-weekly. The rations were computed on the bi-weekly weighings making allowance for the expected increase in weight for the following two weeks.

All feeds were analyzed. Two digestion trials of ten days' duration were run.

The data covering this experiment, as well as data on the previous experiments, is being compiled. At this writing much of the work has been completed, but the final
results and conclusions cannot be included in this report. It is hoped that a bulletin summarizing all this work may be available in a short time.

So far as any physical changes resulting from these feeds are concerned, it might be stated that none were observed. The heifers which were kept on the high and low protein intake until they calved, showed no physical indications that the different rations had any nutritional influence either on the cows or their offspring, both being normal. The milk of these cows was tested and the average analysis indicated very low protein content. However, this was true of the milk from both the high and low protein cows.

The work on this project was discontinued July 1, 1922.

**Hatch Project**

The experimental work on the practicability of milk machines was continued under the following heads:

A. Mechanical Results of Milking Machines.

1. Efficiency of mechanical milkers compared with hand milking.
2. Effects of mechanical milkers upon udders of cows.
3. Effect on length of lactation periods.
4. Effect of not stripping.

B. Bacterial Contamination of Mechanical Milkers.

1. Effect of type of machine on bacterial count of milk.
2. Bacterial count resulting from pipe line, rubber connections, etc.
3. Effect of various solutions in keeping down bacterial count of milk.

This experimental data indicating the time required by a mechanical milker to milk an average cow is about 8½ minutes. Necessarily, the time varies with different cows, as well as with different operators, and their skill and familiarity with the mechanical milker. This time does not include the time spent in washing and caring for the milker, neither is the time spent in repairing the mechanical milker or any of the apparatus necessary to its operation included. When all the time which is spent in the maintenance and operation of the mechanical milker is considered, there is very little saving in time over hand milking. If much time were spent in repair work, and mechanical adjustments, it is questionable whether a saving of time is effected by using a mechanical milker.
Mechanical milkers have been used on many cows in the college herd for some time. No apparent injury has been done to the udder or teats. It is fair to state that with reasonable care mechanical milkers will not injure the udder. From the standpoint of the cow's udder, mechanical milkers, when operated with reasonable care, are to be preferred to most hand milkers. Mechanical milkers will not affect the length of the lactation period, if cows are stripped. Our work indicates that it would not be advisable to discontinue stripping even if at times very little milk is obtained by stripping. The data indicated that the stripping varied from .1 lb. to 2 lbs. on the same cow, with the same machine. This variation would indicate that factors which cannot be controlled may influence the amount of stripplings and therefore it is absolutely necessary to strip when mechanical milkers are used. Two single unit mechanical milkers were used during the entire year, each machine being used for a period of three months on one group of cows and then put on the second group. The change of machine did not have any noticeable effect on the cows. Speeding up the pulsator, however, did seem to affect the cows, as was indicated by their uneasiness and moving of their hind feet.

In summarizing the mechanical results of milk machines the following conclusions seem justifiable:

1. Mechanical milkers will save labor if a sufficient number of cows are being milked. Under average conditions 15 or more cows should be milked before a mechanical milker will be a time saving investment.

2. Mechanical milkers will not injure the udder of the cow, nor cause her to dry up, if reasonable care in its operation is observed.

3. Striping after the use of the mechanical milkers is necessary, as not to do so might cause the cow to dry up. If the milker is left on the cow after practically all the milk is drawn, to avoid stripping, the udder of the cow may be injured.

4. The length of the lactation period of a given cow is an inherited characteristic. However, the lactation period may be shortened by improper methods of mechanical or hand milking.

**Local Station**

The heifers which were previously on the Adams project were continued on the Adams Local until they calved. The heifers have all calved, and as far as physical observa-
tions could ascertain, no abnormalities occurred during the
gestation period, or since, to lead one to believe that the
ration previous to calving had in any way affected the nor-
mal development of the fetus, its delivery, or the milk pro-
duction of the cows.

Since freshening these heifers have been used in an
experiment to determine the feeding value of ground oats
and ground corn with a basal ration of alfalfa and corn
silage.

The work has not been continued long enough to jus-
tify any conclusions but the data seems to indicate that it
does pay from the standpoint of increased milk production
and condition of the cows to add ground corn and oats in
the ration.

At the completion of this investigation detailed report
of this work will be made available for farmers of South
Dakota.

Two investigational problems have been in progress
during the year, carried on by graduate students under the
supervision of this department.

One of these problems dealt with the Vitamine “C” or
anti-scorbutic vitamine in cow’s milk.

The milks which were compared were produced by
cows which had never received any green feed, and cows
which were on a normal winter ration. The method and
results of this investigation have been compiled into a well
written thesis and is on file in the college library. In sum-
marizing the data of this investigation the following con-
clusions were deduced:

1. Cow’s milk contains the anti-scorbutic, or Vita-
mine “C.”

2. The fact that cows do not have access to green feed
does not seem to affect to any appreciable extent the Vita-
mine “C” content of their milk.

3. Vitamine “C” is readily destroyed in cow’s milk by
heating.

4. No appreciable depletion of Vitamine “C” occurred
in cow’s milk as the winter feeding progressed.

These data do not corroborate work of a similar na-
ture done at other stations, hence it seemed advisable to
run a third check. The plan is to do so this winter.

The purpose of the second investigation was to deter-
mine the advisability of adding oilmeal and bran to a basil
ration of corn silage, alfalfa hay, ground oats and ground corn.

It is good dairy management to feed only such feeds, and in such amounts, as will bring the greatest net return, and not impair the health or physical condition of the herd.

Many practical dairymen feel that the increase in milk production due to the addition to the ration of high priced protein feeds such as oilmeal and bran, does not warrant the purchase of such feeds.

Our data is not sufficient from which to draw conclusions yet it would seem from the standpoint of net profits that it is not economical to feed high priced protein feeds, when corn silage, alfalfa hay, corn and oats are available. There is no doubting the fact that production can be increased by feeding these feeds, but whether the increase in production is sufficient to warrant the purchase of high priced protein feeds is still an unsettled question. It is hoped further work can be done on this problem.

The grading-up experiment is still in progress. Females representing the third and fourth generation and two females of the second generation are still in the herd.

The results of this investigation up to date are reported in bulletin No. 198 of this station.

It suffices for this report to say that the data substantiates in unmistakable terms the ability of the good purebred sire to increase the milk production of his progeny. The increase in some cases was surprisingly large, and a glowing tribute to the good purebred dairy sire.

The following bulletins have been written by members of this department during the past year:

Respectfully submitted,

THOMAS M. OLSON,
Dairy Husbandman.