Agroborealis

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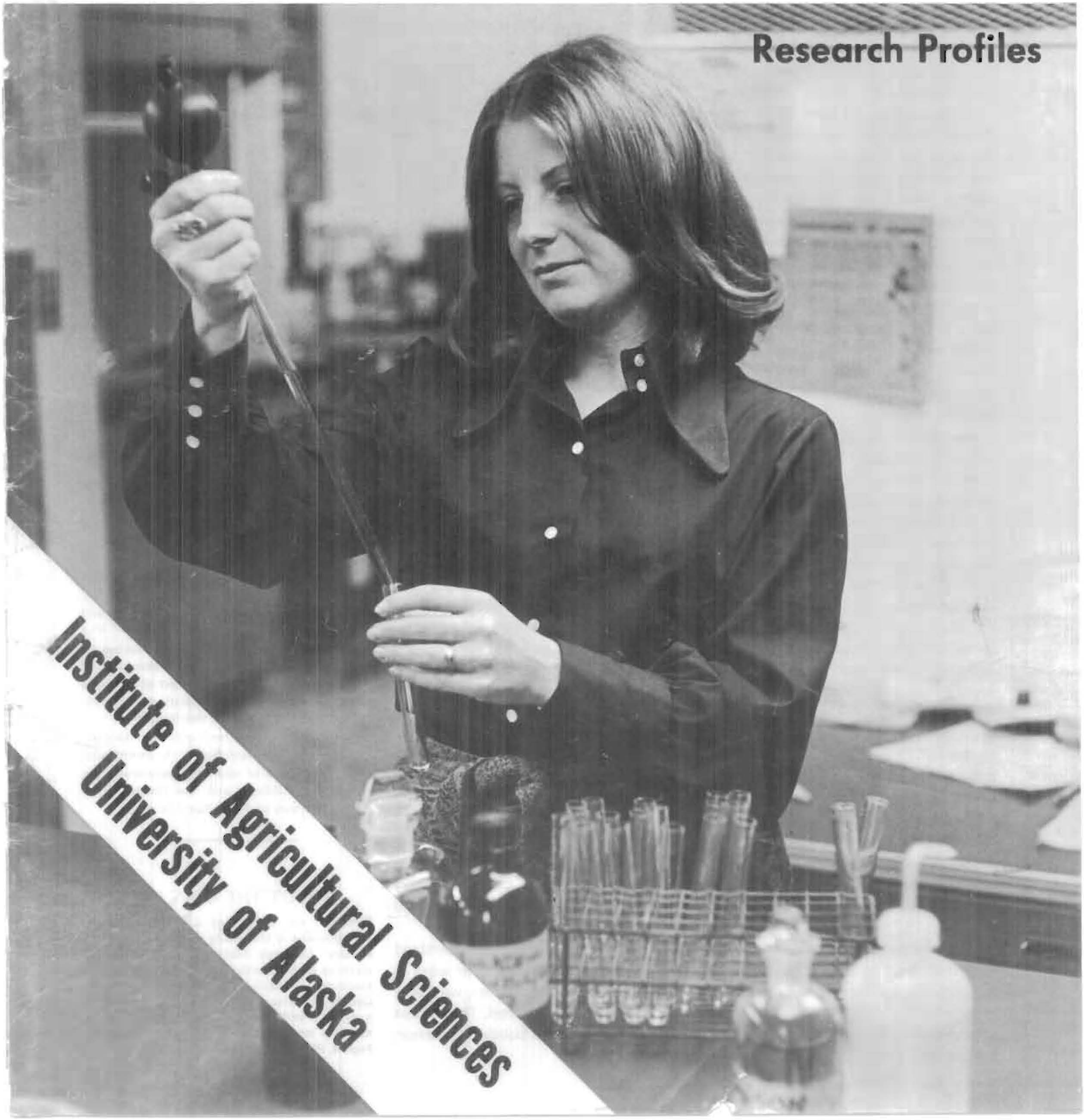

from the Director's Desk . . .

In past issues of Agroborealis we have told you who we are, what we are doing, and why. Now we would like to explain how. Our business, of course, is solving problems, and here is a sampler of case histories to help you see for yourself how it is done. As you read over these stories, I believe you will find that although the details may vary from case to case, we really have only one stock approach to the solution of all problems. It is a simple and logical one, and scientists like to claim it as their very own. As a matter of fact, it is often called "the scientific method". However, as you will see, it is not anyone's private property. You sometimes use it yourself – to find out why your car won't start, for example. It bears a marked resemblance to the old game of "Twenty Questions", with the scientists playing on one side and Mother Nature on the other. It goes something like this: We make a guess (form a hypothesis), ask a question to see if we're on the right track (perform an experiment), think hard about the answer we get (analyze the results), and then, in the light of what we *now* know, revise our guess if necessary and ask another question. This process is repeated over and over until finally the problem is solved.

Director Horace F. Drury

Anyone can play this game, but of course some people are better at it than others. Scientists do it for a living, and they get to be quite proficient. What distinguishes the professional from the amateur is the number of questions he does *not* have to ask. Unnecessary questions just waste time and money and may even sidetrack the investigation completely.

By definition, the scientist is systematic. He collects and organizes all the information on his subject that he can find. He never feels that he has enough and he often spends a good deal of time in search of facts for which he has no immediate use. Experience has taught him that they will all fit together in the end and that he will need every one of them when it comes time to make one of his educated guesses because these guesses are not just shots in the dark. He tries to lead off with the most important question first, and he goes to great pains to frame each question so that nature's answer will be a straightforward "yes" or "no" instead of "maybe" or "sometimes". He takes care not to ask more than one question at a time since one answer is all he is going to get in return, and he can't afford to risk matching it up with the wrong question. That is why he devises such elaborate controls for every experiment. A "control" is merely a clever device for focusing attention on one detail to the exclusion of everything else. In every other respect, control and experimental case are treated exactly alike so that the effects of all other factors are cancelled out. With good planning, one question will result in one decisive answer, and with that point settled, the experimenter can go on to the next.

We hope these glimpses of our scientists in action will help you to understand why they tend to be so cautious about making statements before their work is completed, why they seem to take so long to come up with the answers, why they often wind up with such positive opinions after their work is finished. The process of converting mere guesses to proven facts takes time. It also builds confidence. Besides, it is fun!

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ABOUT THE COVER . . .

Pictured on the front of this issue of Agroborealis is University of Alaska graduate student Deborah McCown who is shown working in the horticultural laboratory at the Institute of Agricultural Sciences Research Center in College. Ms. McCown is working on a project with Dr. Donald Dinkel involving nitrogen metabolism in potatoes. See story on Page 4. Photo by Editor William L. Fox.

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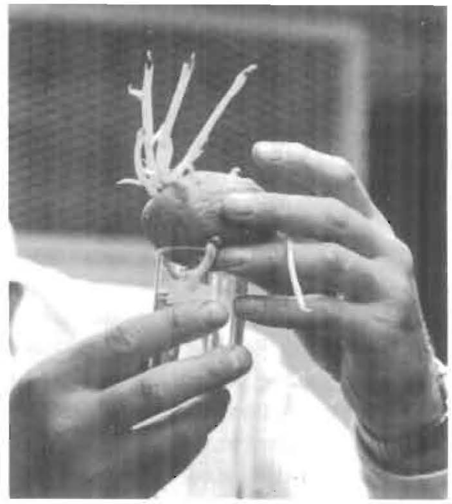
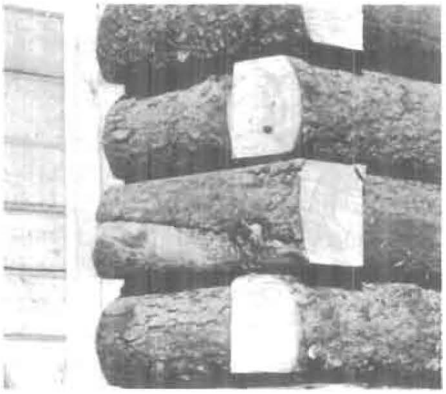




The potato: 'A convenient little package'

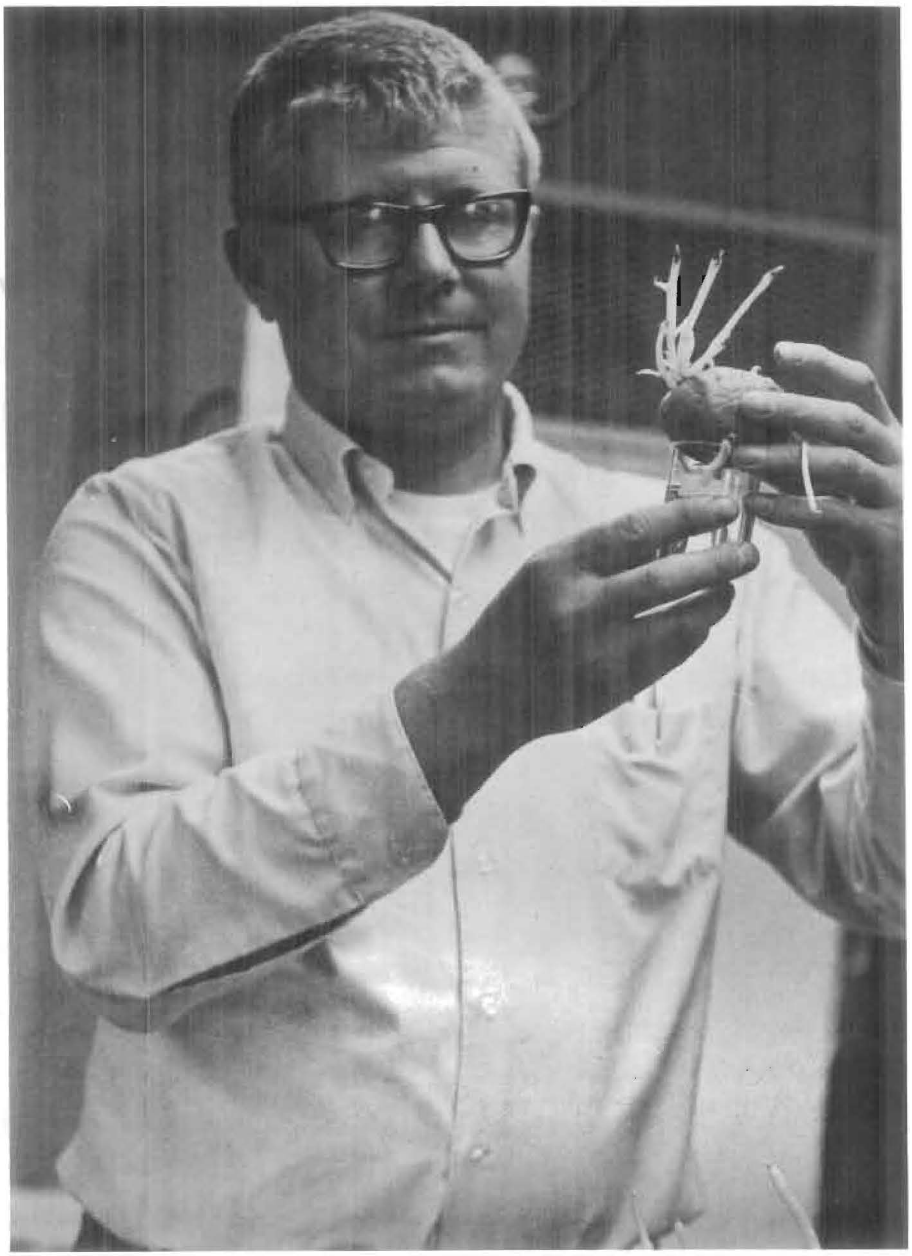
Studying nitrogen metabolism

Have you ever stopped to consider the workings of a potato? Probably not. In fact, at first glance a potato probably doesn't give the impression of being a complex collection of metabolic processes . . . at least, not to the untrained eye. But scientists know better.

Dr. Donald Dinkel, associate professor in plant physiology for the University of Alaska's Institute of Agricultural Sciences, has been studying the potato for the past 10 years because, in his words, the potato is "a convenient little package" which contains many of the plant processes which have intrigued scientists for years.

Indeed, the potato, or specifically the tuber, has a number of interesting characteristics which make it a prime target for intense scientific scrutiny. Among other things, the tuber goes through an extended period of dormancy, it carries out certain storage functions, and it is the organ for propagating the species, which make it unique.

Dinkel became most interested in the potato while he was in graduate school. He was intrigued by the effects of gravity on plants and decided to experiment with the potato. He thought that perhaps he could affect the dormancy and development of a potato by altering the normal gravitational forces on the tuber and decided to place the tuber in a centrifuge and spin it in such a way that the gravitational force on the tuber was increased more than 1,000 times.



Dr. Don Dinkel shows off some of various results his potatoes have produced

The results of Dinkel's experiment were fascinating, although inconclusive and, at the time, entirely baffling. He planted the potatoes which had undergone the centrifuge treatment with others which had received nothing more than the normal gravitational force. Then he waited for something to happen. He didn't know exactly what he was waiting for, but he was on the lookout for anything.

He had planted the tubers in sand which was completely devoid of all nutrients normally present in soil. All of the tubers developed a healthy root system and sent shoots to the surface of the sand. At that point, however, the potatoes which had not been placed in the centrifuge stopped growing. Some of the others, which had been subjected to the tremendous gravitation force, continued to grow.

Dinkel knew he had discovered something, but he wasn't sure what. His preliminary theories practically went down the drain when he conducted his next experiment. He went through the same procedures with the centrifuge and planting and waited for results. And he got them, but they were different from those of his first test. All the tubers developed healthy plants.

On checking back over his experiment, Dinkel realized that he had planted the tubers in fertile soil, not in the sand in which he had conducted his first test. By changing this variable, Dinkel lost a year's worth of research. Or had he? It made him suspect a number of things and he set to work looking for proof.

Subsequent experiments were conducted and in all of them a type of insulation — Perlite — was used in place

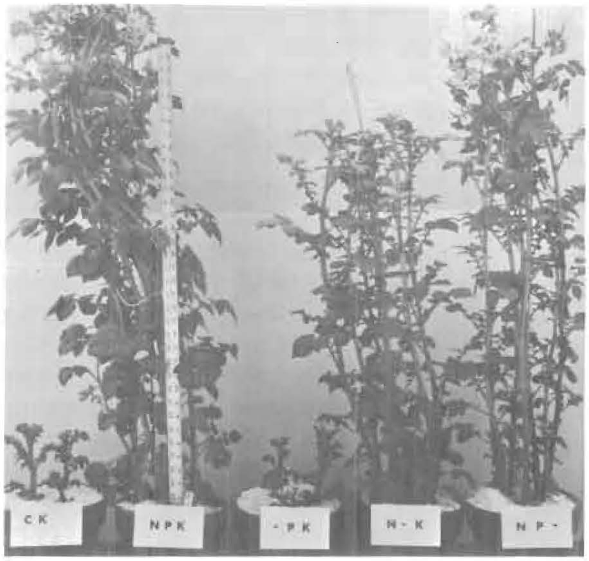


Figure 1

Figure 2

Figures 1 and 2 show comparisons of development of centrifugalized potato tubers grown under different conditions. Both experiments used Perlite in place of soil. In studying the effects of various nutrients on plant development (Figure 1) of five tubers planted, the two without nitrogen in the Perlite developed poorly, while the other three thrived. Figure 2 shows results of another test which experimented not only with the use of nutrients in the Perlite, but also checked effects of light and darkness on plant development. Here, plants which were given no nutrients developed poorly, although the plants grown in the darkness and void of nutrients developed to a far greater extent than those which grew with no nutrients in the light.

of the sand or soil. The Perlite was devoid of nutrients and provided a good material for planting. Once again, some of the tubers which had taken a ride in the centrifuge produced good healthy plants, while those which had not been spun developed only to the surface of the Perlite. It appeared that once the plants which had not been centrifuged reached daylight, they were unable to grow further.

Further testing involving plant development in darkness confirmed some of Dinkel's suspicions: both the tubers which had been centrifuged and those which had not been placed in the centrifuge developed roots and stems which broke through the surface of the Perlite and grew several inches. However, because there was no light, no leaves developed and there was no synthesis. When the plants were finally subjected to light, the ones which had grown from the centrifuged tubers continued growth and leaves began to form. Growth on the other plants ceased.

The problem in plant development was obviously a nutritional one and Dinkel began to test for possible unavailability of one or more nutrients necessary for plant growth. Nitrogen, potassium and phosphate availability in tubers was checked by growing tubers in Perlite lacking each of these nutrients separately but containing all other nutrients. It became apparent that a lack of nitrogen in the growing medium (Perlite) was inhibiting the growth of leaves on the plants which had not been subjected to the centrifuge treatment. Somehow centrifugation produced tubers that were able to supply the plant with adequate nutrients for normal growth. Dinkel realized that the tubers actually had a stockpile of various nutrients inside them, although without treatment in the centrifuge, the nitrogen was unavailable to the growing plant until the tuber had gone through its stages of dormancy and aging.

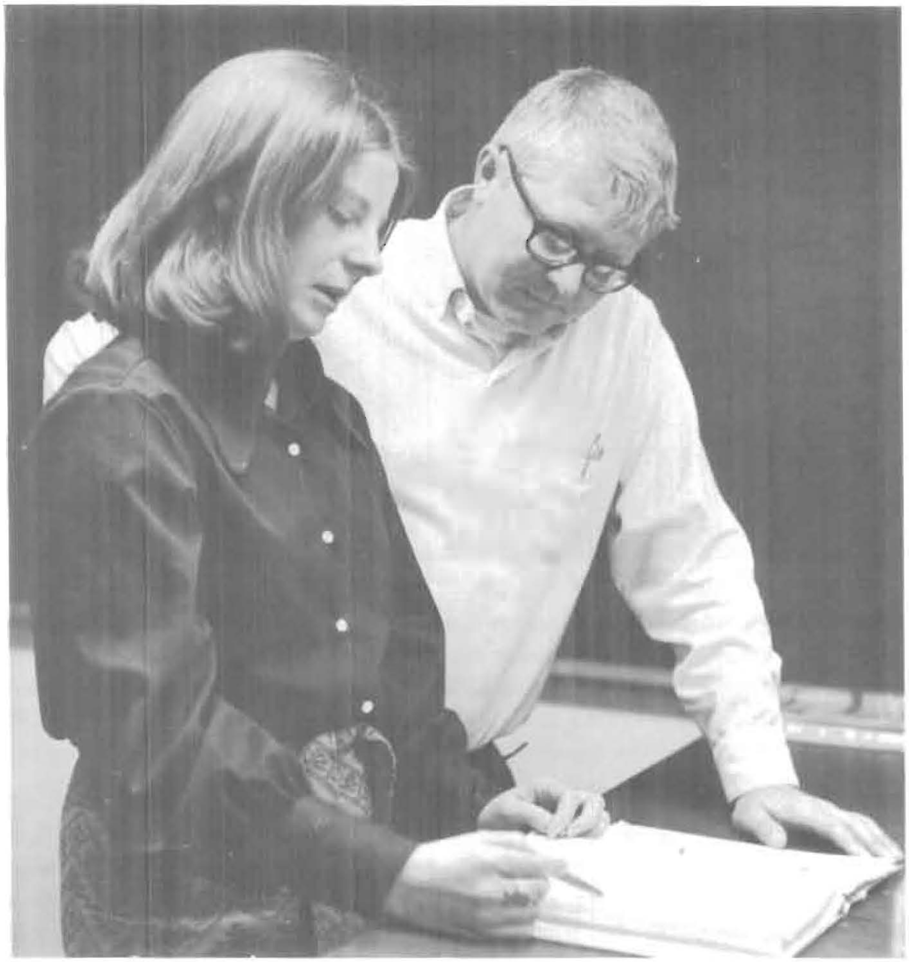
As often happens, the answer to one question raised numerous other questions. In testing for lack of nutrients, Dinkel found that only the roots of the plant would pick up the nutrition necessary to make the plant develop leaves. He tried to spray the shoots with various inorganic and organic nitrogen compounds and he tried to swab the tuber in an effort to make it produce, but his efforts in these areas proved fruitless. His only means of getting nitrogen into the plant where it would do some good was by applying inorganic nitrogen fertilizer to the Perlite and having this nutrient taken up through the roots.

When a tuber is first taken off the mother potato plant, it generally will produce nothing for 30 to 40 days. Then, for a period ranging from 30 days to four months, it will produce shoots without leaves in the dark, but won't develop normally in the light unless supplemental nitrogen is provided through the roots. For the following two to three months, it will produce a normal potato plant and other tubers, using nourishment both from the soil and from the supply stored within the original tuber.

A tuber seems to improve with age in regards to yield produced. For example, it has been shown that a plant developed from an eight-month-old tuber will produce tubers earlier than a plant which grew from a six-month-old tuber. The results which Dinkel produced with his centrifuge seem to indicate that perhaps he can speed up the physiological aging of the potato by subjecting it to a period of increased gravity.

In the case of a tuber which is not subjected to a centrifuge, it appears to be only a matter of time (three to five months) before the nitrogen which is locked up inside the tuber can become available to the plant for development of leaves which, of course, are all-important in the process of synthesis.

Dinkel, in a sense, may be speeding



Dr. Dinkel and graduate student Debbie McCown compare notes

up nature with the centrifuge, although his work has barely scratched the surface as far as piling up proof to support his theories. Certainly, though, his experiments to this point have raised some interesting possibilities. It definitely appears that the tuber possesses a good supply of nitrogen, although this nitrogen is not immediately available for plant development. Somehow (and this is one of the biggest questions now confronting Dinkel) the centrifuge is able to "shake loose" this nitrogen and put it in a form which makes it valuable as a nutrient to the plant.

Dinkel is fortunate this year in having the assistance of a University of Alaska graduate student, Deborah McCown, who is working on a Master of Science degree in Botany. Debbie has been working closely with Dr. Dinkel on his centrifuge experiments and during the next several months should make a major contribution to the project while she prepares her dissertation: "Mechanisms of Light-Inhibited Shoot Growth in *Solanum tuberosum.*"

Debbie plans to study the tuber from a chemical aspect and tear it down at its various stages to determine just what form this mysterious nitrogen supply takes before it becomes available as a plant nutrient. There are many different

HARDY AMARYLIS
Nitrogen Shows Its Effect

forms of nitrogen storage and, although she has some idea of what she may discover, it will take many hours of work in the lab before she can deliver the proof she is seeking.

She will compare tubers in all stages and intends to study not only those tubers which have been centrifuged, but also those which have not undergone centrifuge treatment, but are receiving inorganic nitrogen on a supplementary basis. If she can determine exactly what form the nitrogen takes inside a tuber, Dinkel should have a great deal better understanding of exactly what the centrifuge does to a tuber to speed its development.

One of the problems of the centrifuge experiments has been the high mortality rate of the plants which have undergone treatment. Dinkel says that about 80 per cent of the tubers which are put in the centrifuge die before they produce plant growth of any significance. He attributes this to the rapid aging process to which the tuber has been subjected and believes that it is simply the tuber's inability to ward off pathogenic organisms that causes its death. Dinkel feels that the resistance of a tuber is very low after it has been put through the centrifuge and this is, of course, another problem he would like to solve.

If the nitrogen metabolism mystery is eventually solved, it could have some far-reaching results, not only in Alaska but throughout the world. It could lead, for instance, to new ways of storing potatoes for longer periods of time and keep them from developing sprouts. It would also allow farmers to get a tuber ready for growing several months before it would ordinarily be able to produce a plant — in other words, eliminating the lengthy period of dormancy. The research could eventually lead to a more controlled growth of the potato with an increase in production.

Dinkel's work with the centrifuge and the potato tuber started as a matter of personal curiosity as do many complex research projects. The ultimate goal in any study of this type, of course, is to come up with either more quality or quantity in a certain plant . . . or perhaps even a whole list of plants. Dinkel, however, is presently concerning himself with one of the most basic levels of this study.

"Often the hardest part of this type of research is actually defining the question that is to be answered," said Dinkel. "I have been able to tie light inhibition to nitrogen availability and that's been my real progress so far. The centrifugation was interesting, but nitrogen synthesis is the big thing in this case."

One of the more valuable side benefits of Dinkel's work with the tuber has been his work with Debbie. Although there have been other University of Alaska graduate students involved in projects of the Institute of Agricultural Sciences, it has not really developed into an established program. Dinkel hopes such a program will evolve sometime soon. It not only gives students an outstanding opportunity to work closely with experienced scientists, but it allows the staff of the Institute of Agricultural Sciences a chance to keep up their teaching and at the same time continue their learning. In addition, the graduate students can contribute significantly to the testing and gathering of information necessary in most of the research projects.

It's difficult to pinpoint the exact progress Dinkel has made so far in his nitrogen metabolism studies since he has not been able to devote his fulltime attention to the project. He has also raised so many new questions that it appears his work will never be finished. He has presented himself with a whole new list of problems:

—Why will a tuber only use supplemental nitrogen taken up through the roots?

—Why is there such a high mortality rate in tubers which have been centrifuged?

—What form does nitrogen take during the tuber's stages of dormancy and aging?

—Could his findings also be applied to other storage organs such as bulbs or seeds?

This is the price Dinkel must pay for his curiosity, but then to Dinkel the price is right.

"I don't ever want to get into a rut," he says with a grin. It doesn't look as though he will have enough time for that.

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Dr. Allan Mick dies in Anchorage

Former director of Alaska Agricultural Experiment Station succumbs Aug. 29

Former Director Dr. Allan H. Mick, 59, died August 29 at Providence Hospital in Anchorage, after more than twenty years of service with the Alaska Agricultural Experiment Station. He served as director from 1957 until he retired from civil service in 1969. Born in Chicago, Illinois, June 14, 1912, Mick earned his bachelor and doctorate degrees from Michigan State College in East Lansing. He was associate professor of Soil Science at that school 1946-48, after serving with the 102nd Infantry Division of the 9th Army in the European Theater during World War II. During his military service, 1942-46, he attained the rank of major.

Dr. Allan Mick

In 1948, he came to Alaska as a soil scientist. In 1952 he was named director of the University of Alaska Cooperative Extension Service and assistant director of the Experiment Station. He served as head of the Soil Science department until he assumed the station directorship in 1957.

Dr. Mick was very active in community affairs. He served on the Valley Hospital board, the Palmer Library board, and in the local branch of the American Cancer Society. He worked toward the encouragement of tourism in the Valley and was a primary force in having the Palmer Visitor's Information Center built. He was elected to receive the Alaska Press Club's award one year as well.

Survivors include a son, Colin, completing graduate studies in communications science at Stanford University in Palo Alto, California; two daughters, Mrs. James (Shannon) Carpenter of Anchorage and Kerry of the family home near Palmer; and a brother, Leland, of Flint, Michigan. His wife, Lucille Kennedy Mick, died here December 29, 1964.

Cold roof design of experimental cabins shows no icicles and a heavy snow cover. Several insulating materials were tested.

Alaska: a giant refrigerator

Importance of a vapor barrier

Many people think of Alaska as a giant refrigerator, but only because they don't know the facts. C. Ivan Branton once thought of Alaska as a big ice box, too, but he had a good reason. He was trying to solve a problem.

Branton, research agricultural engineer for the University of Alaska's Institute of Agricultural Sciences, was looking for a better way of building houses in Alaska. Specifically, he was seeking a cheaper way of building a home, a cheaper way of heating it and a method of controlling condensation. He found all three and during part of his research it was important for him to envision Alaska as a refrigerator.

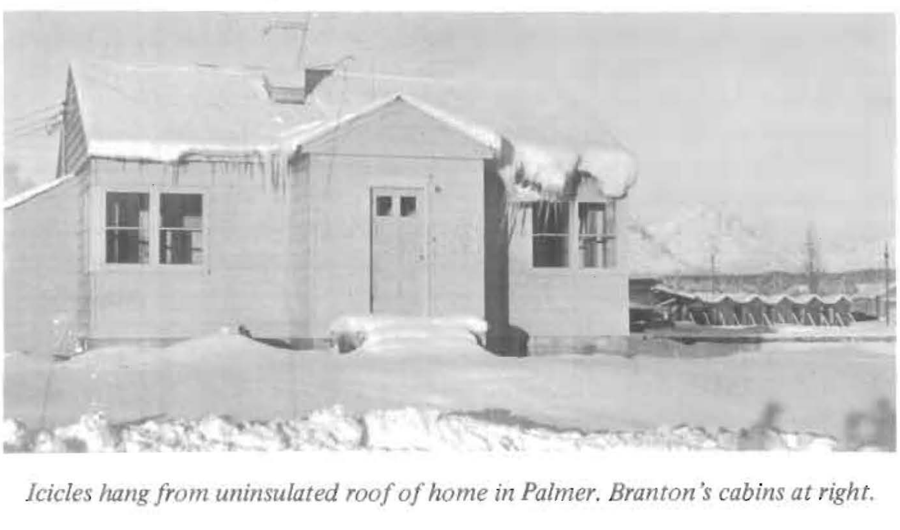
"I wanted to work out ways of using building materials native to Alaska," said Branton. "The cost of farming was so high that I thought I could help agriculture in Alaska by reducing the cost of building. At the same time, I thought we could cut down on heating costs during the winter by trying a vapor barrier in construction. Vapor barriers were not being used in Alaska at all then."

That was in 1951 and Branton had just finished a course in refrigeration. He knew that a vapor barrier is an essential part of a good refrigeration system and he wondered if it wasn't possible to apply this theory to construction in the Far North.

"After all, a house in Alaska is nothing more than a refrigerator turned inside-out," said Branton. "I didn't see why a vapor barrier couldn't keep cold out if it could keep it in."

So Branton set to work on an experiment which he hoped would prove his theory. First, he built 13 small cabins at the Palmer Research Center. No two were exactly alike, although several bore similarities. Only one of the cabins was of conventional frame construction, built of finished commercial-grade materials which were shipped in from outside Alaska and insulated with commercial two-inch batt-type insulation. Light weight building paper was placed between the sheathing and exterior siding — a general practice among many builders at that time.

Eight of the cabins were built of logs (either spruce or cottonwood) cut on three sides and roughly six inches thick. No insulation was used in the log construction, but half of the cabins were constructed with vapor barriers. Roll roofing was used for the vapor barriers in that experiment, although since then it has been replaced by polyethylene, paper-backed aluminum or some sort of laminated or duplex



Icicles hang from uninsulated roof of home in Palmer. Branton's cabins at right.

papers with a continuous sheet of asphalt sandwiched between two sheets of paper. The roll roofing was a good vapor barrier, but was hard to work with, especially in cold weather, and it was difficult to seal at the joints.

The other four cabins were constructed of unfinished Alaskan lumber and insulated with sawdust in three cases and moss in the fourth. Three of the cabins, including the one insulated with moss, also incorporated with a vapor barrier.

After a winter of testing the various cabins for air leakage, heat loss, and condensation problems, it was apparent that the vapor barrier was the single most important factor in the experiment. Heated cabins were more comfortable and required less fuel when a vapor barrier was installed close to the interior surface of the building.
building.

In a summary of the experiment which was contained in a 20-page booklet called "Use of Native Alaskan Materials for Farm and Home Construction" Branton reported the vapor barrier had resulted in:

- A reduction of 66 per cent in air leakage through the walls.
- A decrease of 41 per cent in the amount of moisture required to maintain a comfortable humidity.
- A reduction of 22 per cent in the amount of heat required to maintain a comfortable temperature.

The experiment also showed that cabins constructed of rough lumber and insulated with either moss or sawdust were somewhat superior to the uninsulated log cabins. It took more heat to keep the log cabins at a constant temperature and there was more water vapor leakage through the walls of the log-constructed buildings.

In using the vapor barrier a "cold roof" was created and Branton found that this eliminated moisture condensation in the attic spaces, icicle formation and glaciering. The experiment was undeniably a success and proved beyond a doubt that the vapor barrier was extremely valuable in Alaskan building design. Branton, however, wasn't through.

After two years of experimental work with the first set of cabins, Branton decided to construct a second set, incorporating some different building techniques. The results of the second experiment, which incorporated the use of polyethylene plastic as a vapor barrier, led to publication of a booklet called "Condensation Control for Alaska's Farms and Homes."

The title alone would have made it a best-seller in Alaska because it seemed nearly everyone was fighting the problem of condensation. As it turned out, more than 10,000 copies of the booklet were distributed through the University of Alaska's Cooperative Extension Service.

Branton recalls one of the biggest demands for the booklet came from the paint stores in Anchorage:

"The people would come into the stores complaining about paint peeling off their houses and claim it was bad paint," said Branton. "But the paint stores would say, 'oh, no, you aren't having problems with the paint. You're having condensation problems.' and they'd hand them a copy of the booklet."

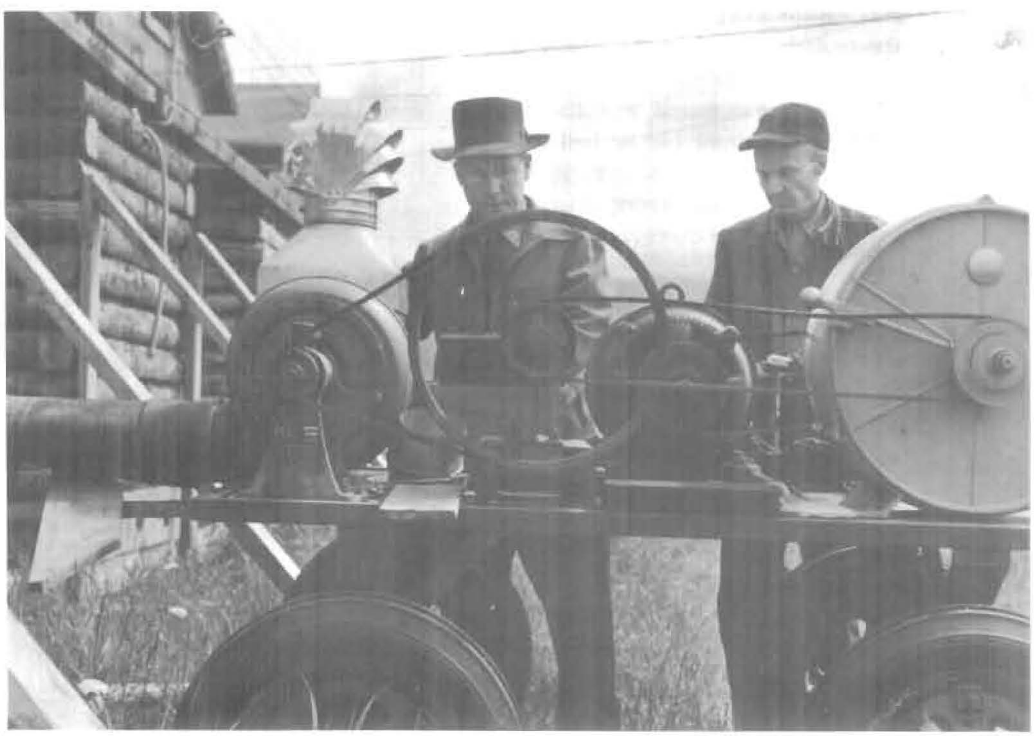
The booklet, which was revised and reissued twice after it was originally published in 1954, answered many questions which Alaskans had asked since the start of home construction. Among other things, the booklet explained, in simple terms, exactly what condensation was and how it was created.

As building practices improved, Alaskans were being permitted to maintain warmer and more humid homes. Construction was tighter and with all this so-called "improvement" it came as somewhat of a shock to builders to find that the problem of condensation became magnified. It was quickly determined that higher temperature and humidity enhance the destructive features of excessive condensation.

Branton's booklet pointed out: "Condensation seldom occurs in older houses because they are so loosely constructed that the exchange of inside and outside air through cracks and around doors and windows is sufficient to remove the excess water vapor, or humidity, within the house."

With the advent of weather-stripping, storm doors and sash, caulking and insulation, came the real problems of condensation. Then came water spots on walls and ceilings, peeling exterior paint and deterioration of structural materials.

Branton had his work cut out for him when he began the experiments with vapor barriers. Everyone was suffering with condensation problems and once the answer was found, Branton had little trouble selling it. He found, however, that a vapor barrier alone would not eliminate condensation. It



Branton, left, prepares to test experimental cabin for air leakage

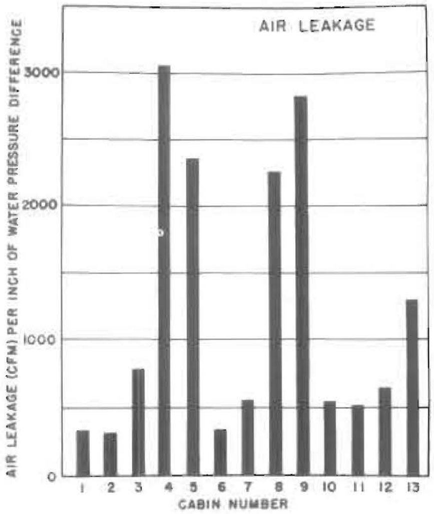


Chart showing results of air leakage tests in 13 experimental cabins shows five cabins without vapor barriers had considerable leakage, although cabin insulated with sawdust (but without a vapor barrier) had least leakage of those five cabins. Most leakage came in cabin No. 4, constructed of sawed green spruce logs and with no insulation or vapor barrier.

took two other ingredients: insulation and ventilation.

The vapor barrier prevented water from entering wall, floor and ceiling spaces. The insulation kept the interior surfaces and the vapor barrier warmer than the dewpoint temperature. And the ventilation was to prevent the accumulation of excessive amounts of water vapor in the air.

Branton also found that the placement of the vapor barrier had a great deal of bearing on its success. In fact, a vapor barrier in the wrong place could cause considerable damage to a building. His experiments showed that the barrier should be placed close to the inside or room side of the wall. His booklet explained that water vapor moves from an area of high vapor pressure to an area of low vapor pressure and thus to prevent vapor movement through the wall of the heated home, the vapor barrier must be placed close to the inside wall, where the higher vapor pressure is located.

In the case of concrete floors, the vapor barrier should be placed over the gravel, but below the concrete to insure that vapor from the ground won't penetrate the floor. A good wall might be built something like this:

Siding on the outside; then a layer of building paper (not a vapor barrier, but a paper which keeps out wind and rain); then outside sheathing; a layer of insulation; then the vapor barrier; and finally a warm inside wall finish. This type of construction guarantees there will be no moisture condensation on the inner wall surface or within the wall space.

Only one of the second set of cabins which Branton constructed was log, the remainder being rough-sawn lumber. They tested a variety of insulations which were native to Alaska. Sawdust was tried once again, along with dirt, grass and ground moss. Fiberglass was also used for comparison purposes. The grass appeared to be the least efficient, although in retrospect, Branton believes this was largely due to the fact that the grass was hard to apply and thus was not packed in as tightly as the other insulation. This finding, however, was all part of the objective of the experiment.

The various insulations were not only tested for their ability to hold heat but were also subjected to air leakage or "blowing tests". This determined the tightness of the walls and involved the use of an electric blower which forced low volumes of air into the cabins. The pressure inside the cabins was then measured and in this way it was determined what types of construction were most air-tight.

Branton's experiments led to a number of findings which had not previously been proven in Alaska. For instance, it was apparent after his first tests that three-sided log cabins were far more difficult to heat than cabins made of rough-sawn lumber and packed with five inches of sawdust insulation. And he also found that the ground dried moss, when properly protected from moisture, made a better insulation than any other native material.

His tests with the cold roof design were unquestionably convincing. For years Alaskans had watched snow melt off their roofs, form icicles along the eaves and, in fact, eventually cause a buildup of ice along the eaves which often backed up along the roof. The reason for all the melting, of course, was because so much heat was escaping from within the dwelling.

When Branton set up an insulated roof with a vapor barrier, the heat loss was greatly reduced and snow cover on the roofs began to pile up. There was no melting, and the snow itself became an insulator.

Branton's experiments showed that cabins required more heat when a strong wind was blowing than they did during a period of much colder weather with no wind.

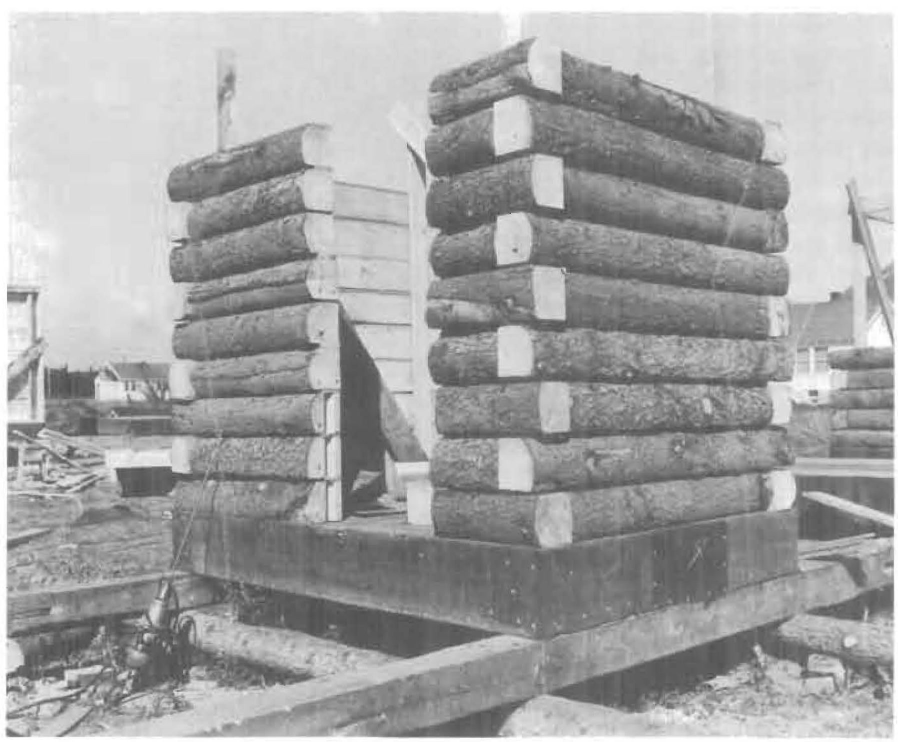


Photo shows walls being constructed on spruce log experimental cabin

Just four years after Branton published his first booklet on Alaska home and farm construction, the Arctic Health Research Center (a subordinate arm of the U. S. Department of Health, Education and Welfare) embarked on a housing study for the Alaska native and used Branton's publication as one of its primary reference materials. In an effort to help the native build a comfortable home at a minimum cost, the Arctic Health Research Center designed an experimental dwelling to be built in Aniak in western Alaska. The town is located in a timbered area and a sawmill was in operation there, so the primary building materials were rough-cut spruce — logged, milled and purchased in Aniak.

Framework of experimental house in Aniak is erected by Eskimo laborers

When it came to construction of this type, Branton was the expert and it was little surprise that the experimental house was packed with sawdust insulation and then fitted with a polyethylene vapor barrier. Double-windows were a part of the structure and the cold roof design was employed to insure a minimum of heat loss. The house turned out to be exactly what Branton had determined the best possible structure using native materials.

In a subsequent booklet ("Studies on Housing for Alaska Natives") published by the Arctic Health Research Center, the house was described this way:

"The Aniak experimental house has been a success from the beginning. The insulation scheme has worked exceedingly well; the occupants found the house comfortable, even keeping the storage room door open so that the room became part of the central core; the interior wood generally showed no sign of condensation or mildew. The efficiency of the sawdust insulation within the six-inch stud space exceeded expectations. . ."

The experiment by the federal government agency simply bore out what Branton had known all along and proven in his tests at Palmer. Nonetheless, it was gratifying to him to see that his recommendations had been used. As for his work with the vapor barrier, it has become universally accepted. Branton's "refrigerator turned inside-out theory" about Alaska has been paying dividends to Alaskan homeowners for nearly 20 years now.

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Dr. Thomas joins faculty at College

Agricultural economics research at the University of Alaska has been augmented by the addition of Dr. Wayne C. Thomas, assistant professor of economics, to the Institute of Agricultural Sciences faculty at College. Dr. Thomas arrived in March of this year from Pullman, Washington, upon completion of the Ph.D. degree in agricultural economics from Washington State University. He also holds a B.S. degree in animal science from California State Polytechnic College and an M.S. degree in agricultural economics from the University of Nevada.

Dr. Thomas

Initially Dr. Thomas will be conducting research on the marketing of red meats in Alaska, both state-produced and imported. He will also be doing work in rural resource development. The research program will be statewide in scope.

Dr. Thomas was accompanied to Alaska by his wife Monica, and their infant daughter Catherine.

Grain breeding shows success, but further work remains

Roscoe Taylor, research agronomist, checks a stand of oats in experimental plot at the Matanuska Research Farm.

Cereals play an important role in Alaska's livestock feed picture and for over 20 years scientists at the University of Alaska's Institute of Agricultural Sciences have been working to develop a high-producing grain which can withstand the rigors of the Alaskan environment and cope with the limited growing season.

To call this work a challenge would no doubt be regarded as a gross understatement by Roscoe Taylor who has been involved in an intense experimental program since 1952. Taylor, a research agronomist at the Institute of Agricultural Sciences, has tested thousands of varieties of barley, oats and wheat in an effort to come up with the best combination for Alaska. The work has not been easy and at times it has yielded little but frustration.

Nonetheless, today, after years of sorting and testing (much of it by trial and error), there are some grain varieties which are being grown successfully in Alaska. As Taylor points out, though, "Cereals are one of many classes of crops grown in Alaska which did not find an ideal environment here. Within the tremendous range of variability of each cereal some varieties perform much better than others. The entire cereal research program in Alaska at present is directed toward developing better varieties for use in the state."

A "better variety" in this case is a better yield. To achieve this, however, many factors must be taken into account. Taylor explains it this way:

"It would be wonderful to direct a program toward genetic improvement of yield. However, in reality, we are dealing with what I call harvestable yield, or the grain actually obtained at the end of a commercial production operation, Here we are attempting to cope with many factors, both genetic and environmental. Proper management is of critical importance in obtaining maximum yields. However, we are attempting to develop varieties which will produce satisfactory yields under a minimum level of management practices, largely because the best management is probably not attainable by a very large segment of the producers."

Over the years, Taylor has been able to sort through thousands of varieties of grains, discarding many immediately, and gradually – through a process of elimination – working down to a select few which show the most promise in Alaska. He is now concentrating on a program of plant breeding which he hopes will bring out the best qualities of many varieties and put them into one plant – or even several.

Taylor has drawn his samples from several sources. World collections of grains maintained by the U. S. Department of Agriculture were the basis of some of the earliest work in Alaska during the 1950s. Each year further selections are made from that same source and as Taylor learns more about grains grown in Alaska, he is able to make more accurate selections.

Taylor also studies new releases (and breeding material) from other areas of the U. S. and the world. Although he cannot test everything available, he has a pretty good idea of what might work in Alaska and makes selections for experimentation on this basis.

One area where Taylor has drawn heavily has been from the Scandinavian countries, where over 100 years of varietal improvement work has already been carried out. Because of the similarity of environments between Alaska and Scandinavian countries, it stands to reason that grains which thrive in that area of Europe might well be suited for use in Alaska. This theory was borne out further when a selection from Sweden (Edda barley) was released in Alaska in the early 1950s. Experiments with this variety were so encouraging that it is now used as the standard of comparison in Alaska.

Of the original 5,000 different varieties of barley in the U.S.D.A. world collection grown here 20 years ago, about 400 varieties were selected the first year for further evaluation or crossing in the Alaska breeding program. Taylor estimates that close to 30 of these selections are still being used as parent plants in the Institute's breeding program in Palmer.

Similarly, some 5,000 varieties of oats and nearly 8,000 wheat varieties in the U.S.D.A. world collection were evaluated here.

Taylor said wheat is not grown much in Alaska because nothing which matures early enough to be of dependable commercial value has been developed. In the field of oats, however, a few fairly good selections have been used in Alaska. Golden Rain oats, a Swedish selection which was introduced in Alaska before Taylor joined the research program, has been fairly popular. It matures early and this gives it an obvious characteristic which would be a benefit to the Alaskan farmer.

Another variety of oats (Nip) has also shown considerable success. Taylor said, however, that the Nip selection, which was introduced in 1955, has not been particularly popular among farmers because of its unusual looking dark kernel. It is a good yielder, however, and packs the same nourishment.

The work which has been done with barley probably best exemplifies the development program which has been followed for the entire plant breeding operation. Although Edda has been produced commercially in Alaska since the 1950s, there is still room for improvement and this is what Taylor is seeking.

In explaining the progress which has been made with barley, Taylor said there are four general areas in which he is working for improvement in addition to yield. These include lodging, shattering, maturity and feeding value.

As far as lodging is concerned, Edda is generally satisfactory. However, with the increased use of irrigation and high fertilization the situation requires a new look and that is what Taylor is presently doing. Through breeding, Taylor is trying to come up with a stronger straw and perhaps, too, a shorter straw. Once a better straw is developed, then the research can shift back to fertilization again in an attempt to achieve a maximum harvestable production.

Shattering has always been a problem (to at least some extent) in the production of barley. In many ways it is related to lodging problems. In most cases where Edda is concerned the principal loss from shattering is where entire heads break off after maturity. Harvest at maturity minimizes this loss, but Taylor hopes to gain at least some improvement through genetic work as well.

Edda has shown satisfactory maturity for use in most of Alaska where barley is grown. However, Taylor hopes to develop an earlier maturing type which would not sacrifice any yield. In this way later plantings (or earlier harvests) would be feasible, depending on the farmer's needs. An earlier maturing plant could conceivably open up new areas to barley planting as well. For instance, in cases where frost remained in the ground through late spring, or where earlier freeze-up occurs (such as higher elevations), a barley variety which required a shorter growing season to mature could mean the difference between harvesting a crop, or having no crop to harvest.

Taylor has been concerned with the protein content of certain barley varieties. "This can be highly influenced by level of fertility, but can also be modified by breeding," said Taylor. "Recently we have been concerned with protein quality, particularly for nonruminant animal feeding. This will be a slow, expensive, time consuming process of improvement."

Finally, through numerous experiments Taylor has been able to develop a hooded barley variety which he hopes will eventually become part of annual forage mixtures. Considerable further study will be required, however, before the full benefits of this hooded variety can be fully assessed.

Numerous breeding procedures have been used in Taylor's experiments and research. The most basic procedure (and probably the most productive) has been the work for improvement among adapted plant types. In this case, Taylor is dealing with material which has already been found generally acceptable in Alaska, but material which he hopes to improve, often in more ways than one. The improvement is generally slow and non-dramatic, but definitely significant.

In addition to the breeding among adapted types, Taylor is constantly working to develop special characteristics through genetics. He explains it this way:

"Here we generally look at one particular weakness of our best materials and look for a genetic source to improve it. Frequently, the chosen parental material is completely unacceptable, in other characters, as a commercial crop. Breeding problems increase since we bring in a lot of unwanted garbage with the qualities we are seeking. Recombination (additional crosses and evaluation) are frequently tried. Progress is slow, but the results may be of real significance. Our program has reached the point of evaluation of several of these types."

This stage of breeding, involving the development of special characteristics, represents a milestone in Taylor's research. When he first began his program of experimentation, the initial goal was to develop a grain which would be suitable for commercial production in Alaska. After some early studies, such a grain was found, but there has always been room for improvement and this improvement work is where Taylor is now occupied. He has planted acres of different selections using a variety of crosses in hopes of developing "the perfect plant" for Alaska. He has come up with some rather weird combinations and although many of them are of no commercial use to Alaska growers, the experiments have been far from failure since they have contributed valuable information about the breeding program itself.

Taylor finds his program hamstrung because it is funded for research, but not for production. Grain farmers in Alaska don't have the land, or in many cases the desire, to produce seed of new grain varieties and thus there is a serious problem of producing seed of new varieties which are developed at the Institute of Agricultural Sciences.

Taylor is on the verge of releasing two new oat and two new barley varieties, but as yet, none of the new selections has been named. The new varieties are direct results of the breeding program which Taylor has conducted so diligently over the past several years.

The two new barley varieties do not necessarily have a much better yield than the Edda barley, although they show promise for a better harvestable yield because they appear stronger and less apt to shatter. The hooded variety, which may find a place in the annual forage production, produces a high enough seed yield to warrant consideration as a grain variety as well.

Workers harvest barley from one of Taylor's experimental plots

The two new oat varieties which Taylor hopes to release soon are quite different. Farmers in most areas are looking for a late maturing forage crop when it comes to oats, but in Alaska the growing season is so short that producing seed of such a variety is unfeasible. One of the new varieties which Taylor has developed is high yielding, in the same maturity class as Golden Rain, and suitable for both grain and forage. The other, a grain type, produces a good yield for an early maturing variety.

In Alaska, where the growing season is short and the land available for farming is limited, high yield is the name of the game. Taylor appears embarked on a never-ending project where dividends are often small and cost always seems high. His success so far, however, is unquestionable since the program has reached a point where he can introduce four new grain varieties especially designed for use in Alaska.

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Potato puzzler:

Solving the potassium deficiency mystery

Leaf necrosis on potato seedling is symptom of potassium deficiency

Anyone shopping in most any Anchorage supermarket can buy good Alaska-grown potatoes throughout the year. Certainly a summer tour through the Matanuska Valley would convince anyone that the potato is well-suited for production in Alaska. The fields are green and the crop plentiful. This wasn't the case 25 years ago.

In fact, there was a time when commercial potato growers in Alaska were confounded by a leaf disorder which threatened to wipe out potato production.

In 1948 federal scientists stationed with the Alaska Agricultural Experiment Station at Matanuska studied the leaf breakdown that potato growers were experiencing and concluded that it was not "early blight". After plant pathologists C. L. Lefebvre and Sid Beecher examined potato leaves in their lab and did not find blight pathogens the problem was referred to Dr. Winston Laughlin, research soil scientist and Dr. Curtis H. Dearborn, research horticulturist. They approached the problem by testing the response of different varieties of potatoes to different combinations of fertilizers.

It was noted in commercial potato growers' fields that plants in some areas of the field had a very dark green leaf color a few days before the real leaf breakdown showed up. This dark green color in many crops indicates a healthy condition but in these fields it was the symptom of trouble in the nutrition of the plants. It was reasoned that the supply of potassium might be too low for good growth but no one had seen leaves of potato plants die from the middle of the plant to the top when potassium was deficient. Instead, potassium deficiency in potatoes had always been associated with dying of the older, lower leaves first. But in the Matanuska Valley the dying of the leaves occurred in the upper portion of the plant and in a few days the entire plant died.

In the early 1950's researchers at the Alaska Agricultural Experiment Station showed potato growers by yield tests that heavier fertilization would improve yields significantly, so growers stepped up the use of fertilizer. In some fields this seemed to intensify the leaf necrosis problem.

Soil samples were taken from affected fields and tested only to learn that there was a good supply of potash in the sample. Since potash seemed adequate, it was suspected perhaps other nutrient elements were lacking. Nitrogen and phosphorus were checked and these too were sufficient. Although the malady did not resemble symptoms of any minor element deficiency, extensive field trials were made to check several elements.

Since the difficulty was sporadic and not troublesome every year, experiments conducted each year from 1951 through 1955 did not reveal a method of controlling the potato leaf disorder. A greenhouse study of two soils by Dearborn and Laughlin during the fall of 1955 which produced severe symptoms in the field the previous season indicated that heavy fertilization was definitely not the sole cause of the disease. They did reveal that some potato varieties were more likely to lose their leaves from this malady than were others, that more liberal use of fertilizer gave better plant growth and that the addition to the fertilizer of minor elements such as magnesium, manganese, copper, zinc, sodium, sulfur and boron would not prevent the occurrence of the leaf disorder.

During the course of these tests representatives of fertilizer manufacturers and other scientists visited the troubled areas of Alaska. Lee Fryer, manager of Pacific Agro, provided special fertilizer mixes for trial, based on Alaskan researcher's apparent needs. In addition, results of chemical analyses of potato plants were provided through his efforts. Dr. George D. Scarseth, Director of Research for the American Farm Research Association, a life-time student of soil fertility problems, came to Alaska in 1955 and studied plant composition and soil fertility in many potato fields. He used the rapid chemical tests of both plant tissues and soils but did not find differences between healthy and necrotic plants that could be related to fertilizer elements being used.

Dr. J. G. Leach, plant pathologist at the University of West Virginia toured some potato fields in 1955 and suggested that the leaf symptoms of necrotic potato plants resembled those occasionally found on rapidly growing tobacco plants deficient in potassium.

In 1956 Dr. Laughlin sprayed potato plants with muriate of potash at weekly intervals and in his words "the response was terrific. It meant the difference between a healthy and a dead plant."

He noted in mid-July that leaf breakdown occurred on unsprayed plants after two straight days of sunshine which followed several cloudy, rainy days. On the third sunny day, necrotic spots showed up throughout the experimental plot, except on the vines which had received the spray.

Three days later, during continuous sunny weather, the spread of the difficulty eased somewhat and some plants even began to show signs of recovery. Less than two weeks later, however, the disease became more severe and even some of the sprayed vines picked up light cases of necrotic spots. Two weeks later the field looked as though it had been frost-killed (although there had not been a frost). Breakdown was extremely rapid on plants that had not been sprayed. Sprayed plants remained green throughout the rest of the season. This was the information Laughlin and Dearborn had been hoping for.

Subsequent tests on the plants showed those which had been unsprayed contained very high nitrogen, medium phosphate and little or no potassium in their tissues. Sprayed plant tissues contained medium to high potassium.

It appeared that sun and rain played an important part in the availability of potassium for the plants. During rainy periods, it was evident plants were getting adequate potassium from the soil, but when it was sunny for an extended period, plant growth was so rapid that the roots appeared unable to

Brown sunken lesion on tuber

absorb potassium enough to satisfy the plant's needs. By the time the plant has reached one-half to two-thirds of its vegetative growth, it must have considerable potassium to continue development. If this potassium is not supplied, then the plant cannot survive.

Once the difficulty was identified as potassium deficiency, it was a matter of determining the right method of correcting the situation. Concentration was placed on the rate and type of application of the potash. Suddenly the experiments became more refined, more precise. The problem had been narrowed immeasurably.

Since muriate of potash fertilizer is not chemically pure, there was still a remote chance that the difficulty could be a shortage of another element.

Paul Martin, a research soil scientist, joined the force working on the potato problem. Low rates of potash were applied with a spray during their most critical period of growth and the results were observed closely. Martin tested the soil in which the plants were grown. He checked the soil before the tubers were planted and after they were harvested. It became clearly evident that the plants simply weren't picking up the potash available in the soil and, in fact, although the potash was plentiful, it was *not* available to the plants.

Possibly micro-organisms within the soil (which have first call on soil nutrients) were using up the potash or storing it in a state which made it unavailable to potato plants. Thus, regardless of the amount of fertilizer which was applied, the plants were unable to get the proper balance of

Leaf tests can be made in the field in minutes using only this equipment

Probably nothing could provide a better illustration of what happens to potato plants which don't receive sufficient potassium than this photo taken of an experimental plot in Palmer in September 1957. Plants at left received potassium in fertilizer form at the rate of 160 pounds per acre. The row at right received no potassium. The plants at left developed well, but those on right died because of lack of fertilizer.

nutrients to keep them thriving. A spray was an answer.

Leaf tests, which can be made in the field in five minutes, can determine just what nutrients have reached the plant. It was fascinating to compare these results with the results Martin was getting in the lab with the soil tests.

An experiment in 1957 on the George Crowther farm gave the scientists even more support for their theory. Potato plots were fertilized with an 11-48-0 mixture, using 60 pounds of nitrogen and 262 pounds of phosphate per acre. Four rates of potassium (as muriate of potash) were applied in the row beneath the seed. Starting June 30, muriate of potash sprays (one per cent solution) were applied twice a week and by July 11 the foliage weight had doubled and a 37 per cent increase in yield of potatoes was recorded at the end of the season. Each potassium increment up to and including 60 pounds per acre also reduced foliage breakdown.

The 80 pound per acre mixture of muriate of potash increased U. S. No. 1 potato yield by 143 per cent and the 160-pound mixture increased the yield 218 per cent. There was no further increase for the 320-pound application to the soil and there were no differences in leaf breakdown or yield as far as the application of the muriate of potash fertilizer was concerned.

The tubers of potato plants which do not receive an adequate supply of potassium for healthy top growth frequently break down, especially after bruising. Small depressions form in the cortical layer. Referred to as brown sunken lesions, they are frequently thought to be caused from bruising during harvesting. However, it has been found that potassium deficiency in the plant results in potatoes with a high starch content and it in turn makes the tubers susceptible to brown sunken lesions.

Often the brown sunken lesions are found where there is no visible bruise on the outside of the tuber. Dehydration occurs for a depth of one-eighth to one-quarter of an inch beneath the surface of the potato skin where the lesions form and when viewed through the skin, it takes on a brownish-black color. When cut with a knife, it shows up grey. Often the lesion is hollow in its center.

During the various tests with potassium it was noted that the lesions were most common in potatoes which were grown in soil with a low potassium content. Conversely, it was found that as potassium fertilization was increased, the loss of tubers from lesions decreased. Furthermore, in plants where tops were sprayed with potassium, but the soil had not received additional potassium, the frequency of lesions was extremely high. Thus it was evident that spray alone could not supply all the potassium needed.

While the 1957 potassium fertilization experiment was being evaluated, tuber samples were retained by

Dearborn from the "no potassium", 80, 160 and 320-pound treatments to determine whether the potassium level on which a crop was grown one year would influence the growth of the crop the following year. In addition, a sample was kept from the 80-pound per acre K_2O plot grown during 1957 at the Matanuska Experiment Farm.

Dearborn planted in four replicates all five potato samples in 1958 in 33 hill plots using a conventional single row planter and uniformly banding 750 pounds of 8-28-16 fertilizer per acre on all of the plots. In other words, all of the samples were treated exactly the same.

Dearborn watched closely every phase of plant development. Data was studied from records of emergence, final number of plants per plot, total yield per plot, yield of U. S. No. 1 potatoes and dry matter of the tubers as measured by specific gravity. No significant differences were found in any of the categories.

Thus it was determined that regardless of whether potatoes used for seed were raised in soils of zero potassium or 320 pounds per acre of potassium, they all have the same potential to produce a marketable crop when grown on soils supplied with 120 pounds or more of potassium per acre.

The refining process of determining right sprays and soil fertilizers continued in 1959 and 1960, some 10 years after scientists had first attacked the problem. It was a test of patience. Heavy rain, unusual drought, early frosts or almost any abnormality in the weather was capable of rendering an experiment useless. In the case of these experiments, it took another whole growing season before any information could be acquired.

The scientists had licked the problem. They had identified the original mystery and found a way to combat it. They had done everything the farmer had asked. However, from a professional standpoint, they're still not entirely satisfied and perhaps they never will be.

They know, and have told the farmers, this:

—When sufficient potassium is not available in the soil, frequent muriate or sulfate of potash sprays during the season can keep the vines green and frequently increase the yield.

—Sulfate of potash sprays are superior to muriate of potash sprays.

—At least 200 pounds of K_2O per acre should be applied at planting time.

They know that adequate potassium applied in banded fertilizer at planting has so far eliminated much of the leaf breakdown in potatoes.

What they don't know, however, is the exact mechanism of the breakdown and its relationship to the length of day, sunlight intensity and soil moisture. If they weren't scientists, this probably wouldn't bother them, but since they are, they won't be thoroughly satisfied until they have the answer.

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Dr. Lin joins agricultural economics research

Dr. Peter C. Lin, assistant professor of economics, has joined the College research program in agricultural economics. He comes to the Institute of Agricultural Sciences from the University teaching faculty. Prior to moving to Alaska, Dr. Lin was assistant professor of business administration at the University of Montana. He was born in Taiwan and holds B.S. and M.S. degrees in agricultural economics from Taiwan Provincial Chung Hsing University. Dr. Lin also holds M.S. and Ph.D. degrees in economics and in agricultural economics from the University of Wisconsin.

Dr. Peter Lin

His primary research effort will concern prediction of the demand for agricultural commodities in Alaska through the year 2000.

Dr. Lin and his wife Mei-ling are expecting their first child in October.

Jim Leekley holds out one of the many hundreds of mink which have been raised at the Petersburg Fur Station

Solving a pair of feeding problems:

A good fish diet for mink

Mink ranching – like any business – has its share of problems. Many of the problems are universal in the industry, but a few are strictly regional and depend either on the environment or feeding procedures. The Petersburg Fur Station, a branch of the University of Alaska's Institute of Agricultural Sciences, has been experimenting with mink ranching (among other things) and working to iron out the problems which plague the industry in Alaska.

Salmon trimmings from canneries made fish wastes an ideal feed for mink, except for two big problems.

Jim Leekley, a fur research biologist, who has headed the Fur Station in Petersburg for much of its existence, has dealt with numerous problems in developing fish rations for mink over the years, many of which were somewhat unique. One of his major objectives has been to work out practical mink diets which utilize high percentages of the many species of so called "scrap fish" or fish which have no value for human consumption and the large amounts of fish scrap or trimmings which are discarded by the canneries, cold storages and fish processing plants in Alaska.

Salmon trimmings from canneries are a very plentiful discarded waste along most of the coast of Alaska and are a good source of easily digestible protein, yet early attempts by Leekley revealed that mink diets containing as little as 30 per cent of this product resulted in a very high mortality among young, growing mink during the summer months. Subsequent research revealed that the cause of these deaths was steatitis – a dietary disease nearly unknown in the mink industry at that time except in isolated instances where large amounts of old or oxidized fatty meats had been fed. Salmon waste products are high in unsaturated fatty acids which oxidize quite rapidly destroying the available Vitamin E in the diet.

Further experimentation established levels of Vitamin E which protected diets containing as much as 50 per cent salmon waste. However, Vitamin E was expensive, difficult to store and, in the case of Alaska ranchers, sometimes hard to obtain. With this in mind, Leekley embarked on a large scale program to explore the use of some of the newly developed fat stabilizing agents or antioxidants in mink diets high in unsaturated fatty acids.

In two year's work, involving 186 female mink and their offspring, it was found that the antioxidant DPPD (diphenyl-p-phenylene diamine) was effective in controlling steatitis when added to high salmon waste diets at a level of 112 grams (1/4 pound) per ton of feed; however, it also produced several detrimental side effects. Breeding was excellent both years but the number of females producing and number of young raised were disappointing. Also, the rate of growth and weights of the kits at pelting time were below those normally obtained on other diets. In the second year's experiment with DPPD, reproduction failure and early loss of young was abnormally high. Only 65 of the 96 females started on the test produced litters and nine of these lost their kits before they were weaned. Moreover, 38 of the 40 females that either lost their litters or did not produce received DPPD on one or both of these tests indicating the likelihood of a definite residual effect.

Next, Leekley tried the antioxidant BHT (butylated hydroxytoluene) for three consecutive years. This identical experiment was designed to test the effectiveness of BHT in preventing steatitis, see if it influenced reproduction and growth or carried any residual effects similar to those obtained from DPPD. Diets containing 50 per cent salmon waste from three different species of salmon – pink salmon, chum salmon and red salmon – were fed with and without BHT. Six similar groups of 16 females each, of standard ranch mink, were carried through their breeding and reproductive period from February until July and half their kits through growing and furring out from July until pelting in December on these diets.

Fish heads were only economical way to feed mink in Alaska, but steatitis made ranching impossible until cure was found.

The first year's results were disappointing in that production was not up to standard on any of the diets – 20 per cent of the bred females failed to produce. However, there was little if any difference in production between those groups which received BHT and the controls which did not receive this antioxidant.

None of the animals receiving chum salmon waste developed steatitis; however, a number of those on pink salmon and red salmon waste diets which were not protected by BHT contracted this disease.

The second year's results with the same number of animals and the same diets were nearly identical to those of the first year. While production was not up to expectations there was no evi-

Effect of Supplementary Iron, BHT and Fur Seal Meat on Mink Production

Lot Number and Supplement	1	2	3	4	5	6	7	8	
Traits	None	BHT[a]	Fe	Fe+ BHT	FSM[b]	BHT + FSM	Fe+ FSM	Fe+BHT, FSM	Total or average
Females									
Start of test	16	16	16	16	16	16	16	16	128
Mated	16	15	16	13	15	16	16	16	123
Producing young	14	13	16	13	12	12	13	15	108
Losing litters	0	1	1	0	0	0	0	0	2
Kits									
Totals									
At 10 days of age	62	55	66	59	57	58	66	74	497
Weaned at 50 days	61	55	65	57	57	58	66	74	493
Averages									
At 10 days per female started	3.9	3.4	4.1	3.7	3.6	3.6	4.1	4.6	3.9
Weaned per female started	3.8	3.4	4.1	3.6	3.6	3.6	4.1	4.6	3.9
Weaned per producing female	4.4	4.2	4.1	4.4	4.8	4.8	5.1	4.9	4.6
Weaning weight, kg.	0.42	0.39	0.39	0.44	0.41	0.43	0.43	0.44	0.42
Least-squares means									
Gains on experimental diets, kg.	0.63	0.68	0.59	0.59	0.60	0.63	0.65	0.67	....
Final weight, kg.	1.55	1.50	1.51	1.51	1.52	1.55	1.56	1.47	....
Pelted									
Incidence of steatitis, %	75.0	0.0	90.9	3.0	52.6	0.0	48.6	0.0	....
Incidence of cotton pelts, %	10.7	0.0	4.5	0.0	15.8	3.2	0.0	0.0	....

[a] Butylated hydroxytoluene.
[b] Fur seal meat.

Table above was compiled from results of experiments conducted by Leekley using variables of BHT, ferrous fumarate and fur seal meat.

Cotton fur disease ruins mink pelt even though it only shows below surface.

dence to indicate that BHT was detrimental nor were any residual effects noted. Steatitis was very effectively controlled and the individual weights of the kits when they were weaned at 50 days of age were satisfactory.

Results of the third year were somewhat in contrast to the two previous experiments. However, they proved conclusively that BHT had no residual toxic effect over a three year period. Reproduction was very good – especially where the antioxidant was fed – weights were normal and no indication of steatitis was observed in the animals on the high pink salmon and red salmon diets which included BHT. This malady occurred to some extent on both untreated diets. No animals on either of the chum salmon diets contracted steatitis.

This success with BHT prompted Leekley to try two other antioxidants in mink diets containing 50 per cent pink

After three years of experimentation, it became evident that BHT had no residual toxic effect.

and red salmon heads – the head is the largest part of the salmon discarded and the easiest part of the waste material to obtain.

Diets containing the antioxidants Santoquin and THBP (Trihydroxybutyrophenone) were compared with a similar diet containing BHT and a control group which did not receive any antioxidant. There were 16 female mink on each of the four diets, eight of which had been born the previous spring and eight with records of past production. The experiment was started on February 17 and continued through the breeding, gestation and lactating periods until the kits were weaned at 50 days of age, then 21 male and 20 female kits were kept on these same diets until pelting in December.

Breeding and production were excellent on all four diets, in fact, somewhat above normal as judged by commercial mink ranch standards where an average of four kits weaned per female is considered very good. Except for steatitis, weaning weights and growth were satisfactory on all diets with the group receiving BHT the best by a small margin. Upon examination at pelting time in December no evidence of steatitis was found in the animals which received any of the three antioxidants. BHT, Santoquin and THBP had all been effective in controlling this malady whereas 92 per cent of the animals on the control diet which did not receive an antioxidant exhibited the disease to the extent that the quality of some of their pelts was affected.

Sometime later Leekley experimented with two more newly developed antioxidants – UOP 88 and UOP 288 – because research with other animals had indicated that they might have some influence on reactivating at least a part of the Vitamin E lost in the breakdown of unsaturated fats. In an experiment much like that described above, which included 50 per cent pink salmon heads in each of four diets, these two products were compared with BHT and a control diet which did not contain an antioxidant. Breeding was satisfactory but the UOP 88 and UOP 288 had a very depressing effect on reproduction. Females in the two groups which received these products averaged only 2.75 kits whereas the unprotected control diet and the one containing the BHT averaged four kits per female.

Fifty kits from each of the four groups were carried through the summer and fall months to pelting on these same diets. No indication of steatitis was found among the animals which received an antioxidant. Three kits in the unprotected control group died from this malady during the summer months and 90 per cent of those pelted had the disease to a varying degree.

After all this work Leekley feels that BHT (butylated hydroxytoluene) has proved to be the most practical anti-

Results of grading of pelts for cotton fur in experiment where mink were fed four levels of ferrous fumarate mixed with basal diet of fish scraps.

	Dark		Mutations	
Lot	Pelted	Cotton	Pelted	Cotton
	no.	no.	no.	no.
1	28	2	30	11
2	29	0	29	0
3	25	0	36	0
4	27	0	33	0

Photo at left shows case of cotton fur (underfur is white in contrast to top fur). At right, a look at normal fur.

oxidant he has used to date and does not hesitate to recommend its use in mink diets high in unsaturated fats. It is reasonably priced, easy to store, and is a dry powder which can easily be incorporated with other dry ration ingredients.

"Cotton fur" is another problem plaguing many mink ranchers and one which Leekley has helped alleviate. This is a dietary disorder characterized by grey to almost snow white underfur, poor growth and size, and general anemia. Cotton fur pelts are usually of such poor size and quality that they are nearly worthless. Never, except in extreme cases, does it affect a high percentage of animals in a herd but instances of five to 10 per cent are not uncommon. Poor quality protein and/or diets bordering on adequacy are usually to blame and it has been found that certain types of fish contain an iron binding factor which makes the iron in mink diets unavailable to the animal thus causing cotton fur.

Other workers found that parenteral or muscular injections of iron prevented cotton fur or reversed the development of this malady if administered before the growth of winter fur was too far advanced. However, no oral or dietary iron compound which could be incorporated successfully with other ration ingredients had been found.

Taking his cue from research on pig anemia, Leekley set up an experiment involving 352 mink kits. Diets containing three different levels of Trans Iron (ferrous fumarate) were compared to an unsupplemented control diet during the growing and furring out period from July to pelting in December.

A few of the best quality animals raised on each diet were kept for breeding purposes and the balance (237) was pelted. Examination by professional fur graders confirmed that none of the animals which had received Trans Iron at any of the three levels fed had cotton fur. Twenty-two per cent of those in the untreated control group were afflicted with this disorder.

To test for possible harmful residual effects and to confirm this first year's results, diets including Trans Iron were fed during the following breeding, gestation and suckling period and 41 kits born on each treatment were carried through to pelting again on the same test rations.

Reproduction was satisfactory on the control and iron supplemented diets and no harmful residual effects were noted. Weights taken at weaning and at 28 day intervals thereafter until pelting were normal and equal to those obtained on most adequate mink diets. The Trans Iron was effective in controlling "cotton" for a second year though the incidence of this disorder was not high among the animals on the untreated diets.

Thus Leekley found a method of controlling cotton fur while retaining the same basic diet and eliminating the need for parenteral or muscular injection. The addition of Trans Iron to the diets has been used effectively in Alaska ever since.

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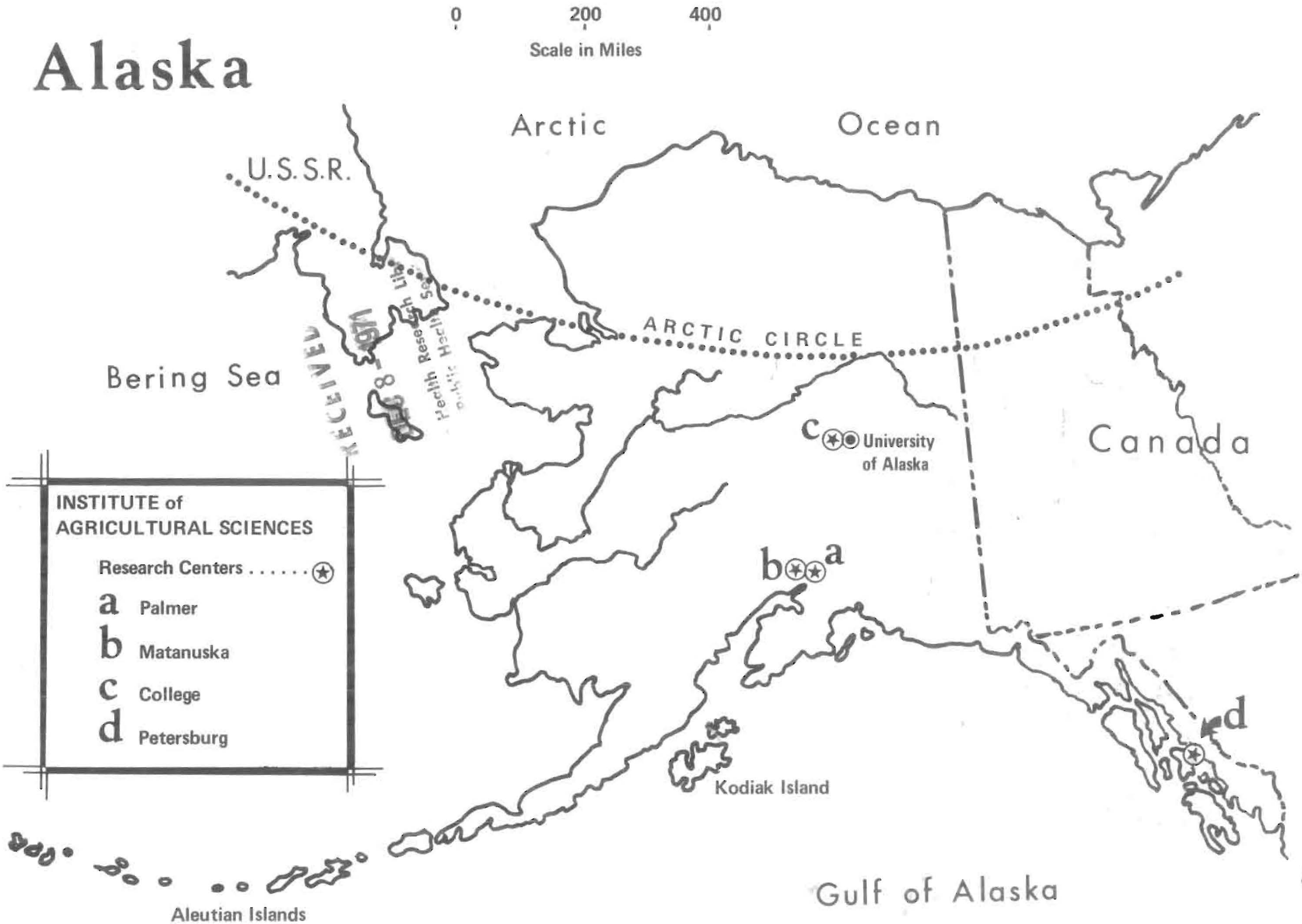
Alaska
0
200
400
Scale in Miles
Arctic Ocean
U.S.S.R.
Bering Sea
ARCTIC CIRCLE
Canada
c University of Alaska
b a
d
Kodiak Island
Aleutian Islands
Gulf of Alaska
INSTITUTE of AGRICULTURAL SCIENCES
Research Centers
a Palmer
b Matanuska
c College
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