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MINNESOTA SCIENCE

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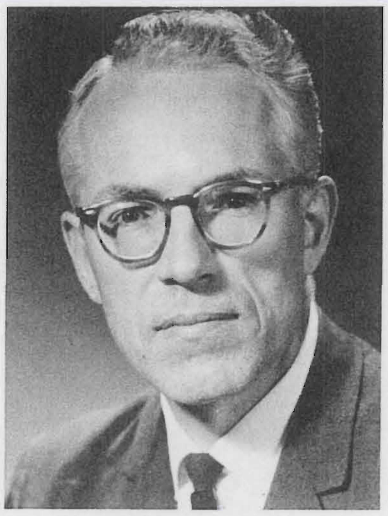
TWO NEW HARDY MINNESOTA APPLES — See Page 13



Dr. William F. Hueg, Jr.

RESEARCH... in a Growing Minnesota

During the last few months we have been bombarded with predictions for the decade of the 1970's and this has been accompanied by an equal number of reviews highlighting the accomplishments of the sixties. But it is always interesting to speculate about "what may be" from the perspective of what has occurred. In this issue of *Minnesota Science* there is an opportunity to see "what is" and to speculate "what might be" as we approach the close of the seventies.

The articles in this issue reflect the diversity of related research programs currently underway at the Minnesota Agricultural Experiment Station. You will read about research that explores the microscopic realm of disease-producing root fungi; you will learn how kernels of corn can be treated with other organisms that keep disease organisms away.

As you read on you will find out how low-valued aspen trees have been put to new uses in home construction, turning this abundant resource into a valuable commercial asset. Another article tells of the progress being made at the Sand Plain Experimental Field near Elk River. Here Minnesota researchers are examining a host of cultural and chemical problems associated with sandy soil types. Irrigating methods, growth hormones, water use efficiency, double cropping, and economic considerations are all being scrutinized as possible means to convert our marginal land resource to more productive uses.

You will also learn about two new hardy apple varieties selected and developed for Minnesota growing conditions. Three recently developed low-fat, low calorie cheeses should also make their way onto consumers' tables in the coming months.

Finally, you will learn about the role that we have played in analyzing the lunar dust brought back by the crews of the Apollo 11 and 12 moon expeditions.

To say that the articles here are diverse is certainly understatement. And yet this is the direction that research has taken over the decades at the Minnesota Agricultural Experiment Station. We have never lost sight of the reason we were established in 1885, but at the same time we remain close to the cutting edge of contemporary problems and opportunities for man and his environment. This issue calls attention to that fact and scans the broad scope of our endeavors in the environmental and life sciences. In fact, this is the area of our research strength and program development.

The dialogue about environment, about ecology, about man, his world and the cosmos that surrounds him, is certainly not new. But it is now taking a higher place and greater focus in man's interest and man's concern.

William F. Hueg, Jr.

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To simplify terminology, trade names of products or equipment occasionally are used. No endorsement of products or firms is intended, nor is criticism implied of those not mentioned.

An Oasis in Minnesota's "DESERT" Plain

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A fiery sun beats down on the twisted spires of dust-green foliage. Hot gusts of wind sweep across the landscape, throwing sand in your face. As you mop your sweat-lined brow, you can feel the fine grit of the sand between your teeth. This might be a scene from the desolate wastes of the Great American desert. But, in fact, the setting is located in the heart of a central Minnesota corn field—corn struggling to survive the withering effects of three rainless weeks in sandy soil.

This scene could have been observed last summer, but it is less likely to be seen in the future, thanks, in part, to efforts of research scientists at the University of Minnesota Agricultural Experiment Station. The Sand Plain Experimental Field near Elk River, Minnesota, was established to develop more efficient use of Minnesota's sandy soil resources. Results gathered after 2 years of experimental trials offer considerable evidence that the state's sandy soils can be productive and profitable.

Several forces were instrumental in initiating this research effort. The obvious problems created by the area's lack of rainfall and its low moisture-holding soils are responsible for relatively low economic returns to farmers and also to communities in areas with similar conditions.

Of the approximately 8 million acres of predominantly sandy soils in Minnesota, it has been estimated that as much as 1 million acres are potentially irrigable. Growers in these areas, Extension agents, Soil Conservation personnel, and other interested groups have long stressed the need for study of this problem. Such demands resulted in the "Anoka Sand Plain Study", an interdepartmental effort aimed at analyzing the agricultural needs and potential of one part of the state's sandy soil resource.* This feasibility study, spearheaded by the Department of Agricultural Economics, in cooperation with the Departments of Soil Science, Agricultural Engineering, and Horticultural Science, led to creation of the Sand Plain Experimental Field.

The Anoka Sand Plain Study uncovered several disadvantages connected with agricultural use of sandy soils. Among these were the soils' low moisture-holding capacity and low ability to hold fertilizer nutrients, and a susceptibility to wind erosion and high summer temperatures. Another disadvantage included long periods of low rainfall and the frequency with which this and other unfavorable conditions occurred. (Of more recent concern would be the

* Smith, F. J., Jr., and Vlasin, Raymond. 1967. A Study of the Economic Feasibility of Vegetable Production on the Anoka Sand Plain.

very dry seasons experienced in many parts of the state during 1967 and 1969.) In addition, severe crop stresses could occur at specific stages in crop growth during short dry periods, even when seasonal precipitation appeared to be adequate for growth. Proper distribution of precipitation, for instance, is especially important for such crops as potatoes (uniform moisture is necessary to avoid unacceptable tuber shapes), corn (particularly critical at tassel and silk stages), and snap beans (high moisture at bloom is required for adequate pod set to occur).

Sandy soils, however, offer several key advantages to farmers. Most coarse textured soils drain rapidly. This aids earlier soil preparation and eliminates serious compaction problems. And since less water is held in these soils, they become warm earlier in spring than heavier soils. All these features combine to make earlier planting feasible, a boon to the producer of fresh-market crops. Sandy soils also allow processors to extend their season since they can process crops earlier. Furthermore, the low water- and nutrient-holding capacities permit operators to move closer to the goal of total crop control: Growers can control growth patterns to a high degree by manipulating water and fertility levels.

Research at Elk River

Crops. Over 50 different crops have been tested at the Sand Plain Experimental Field during the first two growing seasons. Approximately 20 crops have been subjects of intensive research. Primary emphasis has been placed on research with potatoes, snap beans, pickling cucumbers, and corn. All these crops have demonstrated potential or have completely established themselves under irrigation. Other crops that appear worthy of more study include onions, nursery crops, strawberries, alfalfa, asparagus, and fresh-market sweet corn and muskmelons.

Irrigation. Several aspects of irrigation technology have been explored since the project began. Accompanying photographs illustrate the extreme difference between irrigated crops and those relying on nature for moisture. However, irrigation alone is not sufficient. Irrigated field corn can rapidly become nitrogen-deficient if extra nitrogen fertilizer is not applied. Attention must be given to other cultural practices such as insect and disease control, herbicide applications, variety selection, and plant population density, if growers are to reap profitable crops.

Whenever crops are irrigated, a totally new environment is created. This is especially true at the plant level where a highly modified "micro-climate" may exist. Higher relative humidity and the cooling effect of irrigation necessitate greater attention to disease control measures. Plant pathologists are providing advisory assistance with these problems, in addition to conducting specific research projects at Elk River.

Irrigation also increases the effectiveness of some herbicides, but it can adversely affect the performance of others, especially on sandy soils. Totally new recommendations, in terms of the materials used, rates and timing of applications, must be developed for irrigated conditions. Research aimed at obtaining necessary data has been conducted the past two seasons by plant scientists from Horticultural Science and Agronomy and Plant Genetics.

Irrigated plants are more attractive to insects because they grow rapidly and offer an enticing meal to wandering aphids, leafhoppers, beetles, and other hungry "bugs". Staff from the Department of Entomology, Fisheries and Wildlife provided technical assistance in combatting these invaders. In addition, bees for pollination of crops such as pickling cucumbers and muskmelons were made available.

To conduct a definitive program of irrigation research, especially one calculated to measure the response of crops to specific amounts of irrigation, we required a more precise application method than that available with commercial irrigation equipment. Agricultural engineers developed a "small plot irrigator" to meet this need. Advice and assistance in designing the irrigator were provided by personnel from Soil Science, Horticultural Science, and a private engineering firm. Working models were used during the 1968 growing season. Slight design changes were made afterward, and during the 1969 season three "small-plot irrigators" were put into operation. A fourth machine of this type will be constructed for use in 1970.

Major purchases of conventional irrigation equipment have been made and should adequately provide irrigation necessary for research planned for 1970. New "solid-set" irrigation systems, with valve controls for each sprinkler and partial-circle sprinkler heads, will provide even greater "total control" for experiments.

Efficiency of water use. As our population grows, competition for water resources will become keener. This

Transforming sandy soils from marginal production (left photo) into fertile, highly productive oases (right) is the goal of the Sand Plain project. Adding fertilizer and irrigation has increased the yields of some crops by 500 percent, but irrigation alone is not enough.

will make it imperative that growers use water as efficiently as possible. Several types of research on efficient water use are underway at the Sand Plain Experimental Field.

Amending the plant root zone in soils by various methods is one approach being tested. Soil scientists G. R. Blake and R. S. Farnham and horticulturists P. E. Read and D. B. White have conducted tests in which a thin, continuous layer of asphalt is placed beneath the soil surface. Rates and depths of application, irrigation frequency required, and the resulting crop yields and quality are being evaluated. Other soil additives such as peat, vermiculite, compost, and paper pulp are also being investigated, along with various mulching materials and techniques.

Another approach to more efficient use of moisture is modification of plant growth with chemicals. Treatment with chemicals, some of which are hormone-like, has made it possible to manipulate plant growth in several ways. Tomato plants are brought to fruit earlier or later than normal, (depending on the chemical used) and they flower and fruit more heavily. Yields can also be concentrated for mechanized harvesting equipment. Increasing the number of fruits per node by chemical treatment, along with closer plant spacing and other cultural modifications, conceivably could aid in the mechanical harvest of pickling cucumbers. In addition, several chemical treatments have shown promise in enabling plants to resist drought and moisture stresses.

Other promising research. Research conducted by soil scientists C. J. Overdahl and C. P. Klint indicate that irrigation of alfalfa produces striking yield increases. Three cuttings of alfalfa yielded 6.3 tons per acre when irrigated, while non-irrigated plots produced 2.7 tons per acre. Seeding took place in 1968 and data were gathered during the summer of 1969.

Yields of potatoes, although not outstanding, were of a magnitude to indicate excellent potential for future research. Norland yielded 32,700 lbs. per acre and Russet Burbank 36,300 lbs. per acre.

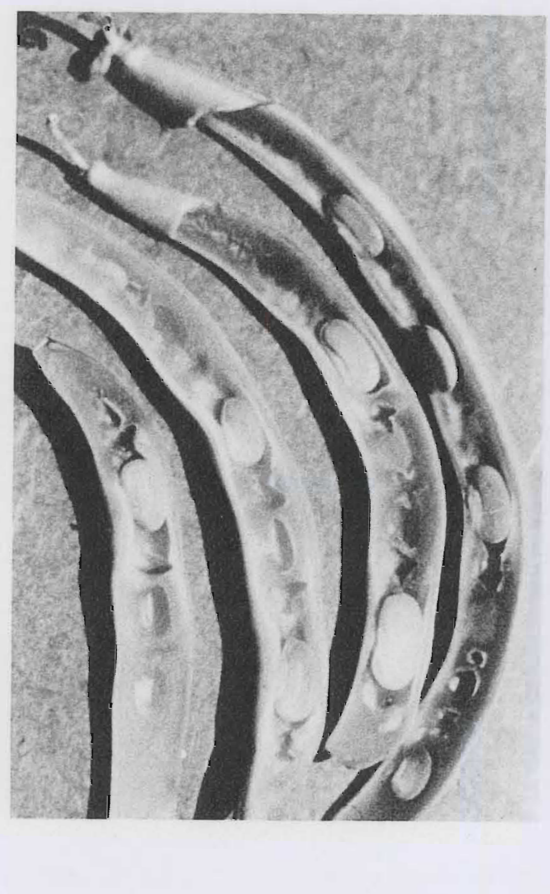
Irrigation alone is not a panacea, as research by agronomist R. G. Robinson illustrated. Yields of sunflowers were increased 59 percent by irrigation, but 159 percent increases were obtained with fertilizer alone, and both fertilizer and irrigation brought yields up 500 percent. Similar responses were recorded for pinto beans, while yellow mustard and horsebeans were less responsive.

Research Plans for 1970

Obviously, further experimentation on sandy soils is warranted. Experiment Station researchers plan to look at additional methods of irrigation. Subsurface types of irrigation, such as the perforated plastic pipe, will be installed and tested. Mist irrigation techniques for cooling crops and controlling plant environments are projected for future studies as well. Experimenters also plan to test irrigation systems through which soluble fertilizers and pesticides can be piped to crops. Finally, 1969 research results suggest that succession cropping (growing two crops in one season) may make irrigation farming a highly profitable operation, rather than a long-range, cost-conscious venture.

The first 2 years' work has merely "scratched the surface" of the potential of Minnesota's sandy soil resources. More work needs to be done to realize the full potential of such soil areas and to convert the "Great Minnesota Desert" into a flowering oasis. □

Growth-regulating chemicals can cause cucumber plants (left) to fruit more heavily and grow to heights suitable for mechanized picking. Problems of quality, such as the interlocular cavities between seeds in the snap beans below (right),are also being studied at Elk River.



LOW-FAT CHEESES DEVELOPED

Three types of low-fat cheese containing only half the calories found in standard cheese have been developed by University food scientist Howard Morris. The three products—a soft French cheese, a Brick cheese, and a Swiss cheese—contain only 14 to 20 percent fat. This is one-third to one-half the amount used in regular cheese, Morris says.

The low-fat cheeses have been test marketed by the University, but have not been accepted by the food industry yet. Sales of natural cheese have been rising steadily of late, so the industry sees little economic potential in marketing the products, he says.

"Current Food and Drug Administration regulations may also explain why commercial food companies are reluctant to market low-fat cheese. These products would have to be sold under the label 'imitation' cheese because of their low fat content. Most companies apparently feel that this would curtail sales," he says.

But Morris expects that consumer demand for low-fat cheeses will be met in the future. He has received countless inquiries from people on diets who are looking for new low-fat foods.

"The purpose of present research is to provide information to the cheese industry. Then commercial firms can make these cheeses when consumer demand increases and the legal situation is remedied."

Morris developed the cheeses through a special technique that gives the products added flavor and soft texture. The milk was homogenized and then heated to denature or cook the whey protein. Hydrogen peroxide and catalase treatment altered the protein so that fat was replaced with water. Microbial growth and enzyme action during the aging process give the low-fat cheeses a more desirable flavor, he says.

Research on low-fat cheeses will continue with Camembert and Gouda cheese, and Morris hopes to have procedures available so industry can eventually manufacture an entire "family" or group of low-fat cheeses. □

Food scientist Howard Morris displays a sample of the new low-fat cheese he developed. It contains only half as much fat as regular Swiss cheese.

MOON DUST and Cockroaches

The epic voyage of Apollo 11 may be remembered by 20th century historians as the most dazzling achievement of the modern age. Neil Armstrong's first footfall on the moon was watched with wonderment in a hundred nations. As viewers watched the American astronaut tread cautiously across the lunar crust, they were acutely conscious that the imprint left behind was far deeper than the mere footprint of a man.

Scientific observers were only slightly less impressed. But as the moonwalk progressed, their thoughts had already turned toward earthly matters. Over 500 scientists from nine nations hurried through final preparations to study the first extraterrestrial materials brought back by astronauts: 60 pounds of lunar rocks and dust.

Among those scientists awaiting the return of Apollo 11 was a woman entomologist, Marion Brooks, an associate professor from the Department of Entomology, Fisheries and Wildlife on the University's St. Paul Campus. Professor Brooks was appointed as a special consultant to NASA's resident entomologist almost 6 months before the historic Apollo 11 flight. Her NASA appointment followed that of two other University scientists, geologist V. Rama Murthy and Robert Pepin, a physicist, both named as principal investigators.

Dr. Brooks was asked to advise NASA on its testing program for live invertebrates—microscopic organisms, insects, and aquatic life. Eight other advisors were assigned to study the animals selected for the tests: the paramecium, planaria, commercial oyster, pink shrimp, German cockroach, house fly, greater wax moth, guppy, and the mummichog (a small fish). All animals were selected on the basis that they are easy to handle and care for, and are relatively common. Each had been studied thoroughly by scientists in the past and so the NASA advisors were intimate with all phases of their life history.

After the Apollo 11 crew returned, the 4½ billion-year-old lunar material was quarantined for several weeks in a vacuum chamber. The group studying invertebrate life eventually received about 4½ pounds of the charcoal-gray substance. They ground up the sample so that no particle was larger than 2 microns (.00005 inches). A portion of the tiny, spherical particles was sterilized for 16 hours at 320° F.

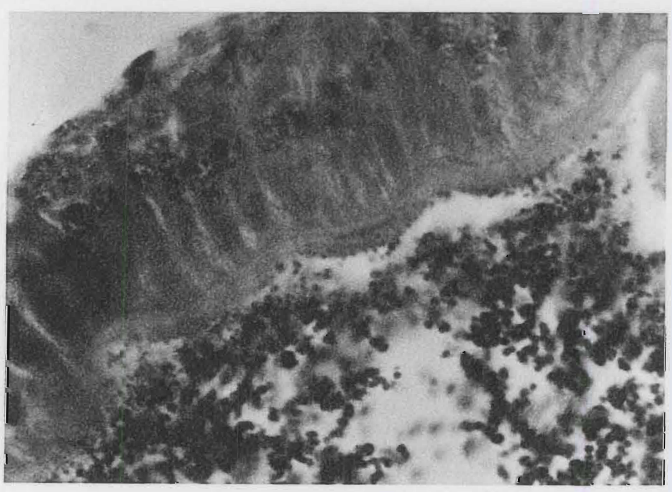
All animals were placed in germ-proof plexiglass chambers 2 weeks prior to testing so they would be fully acclimated to their new homes. One group was treated with the sterilized moon dust, another with raw or unsterilized dust, and the third went untreated and acted as a control group. Some animals were inoculated with dust, some received portions mixed with their food or water, and others walked or crawled through dust spread around the bottom of their containers.

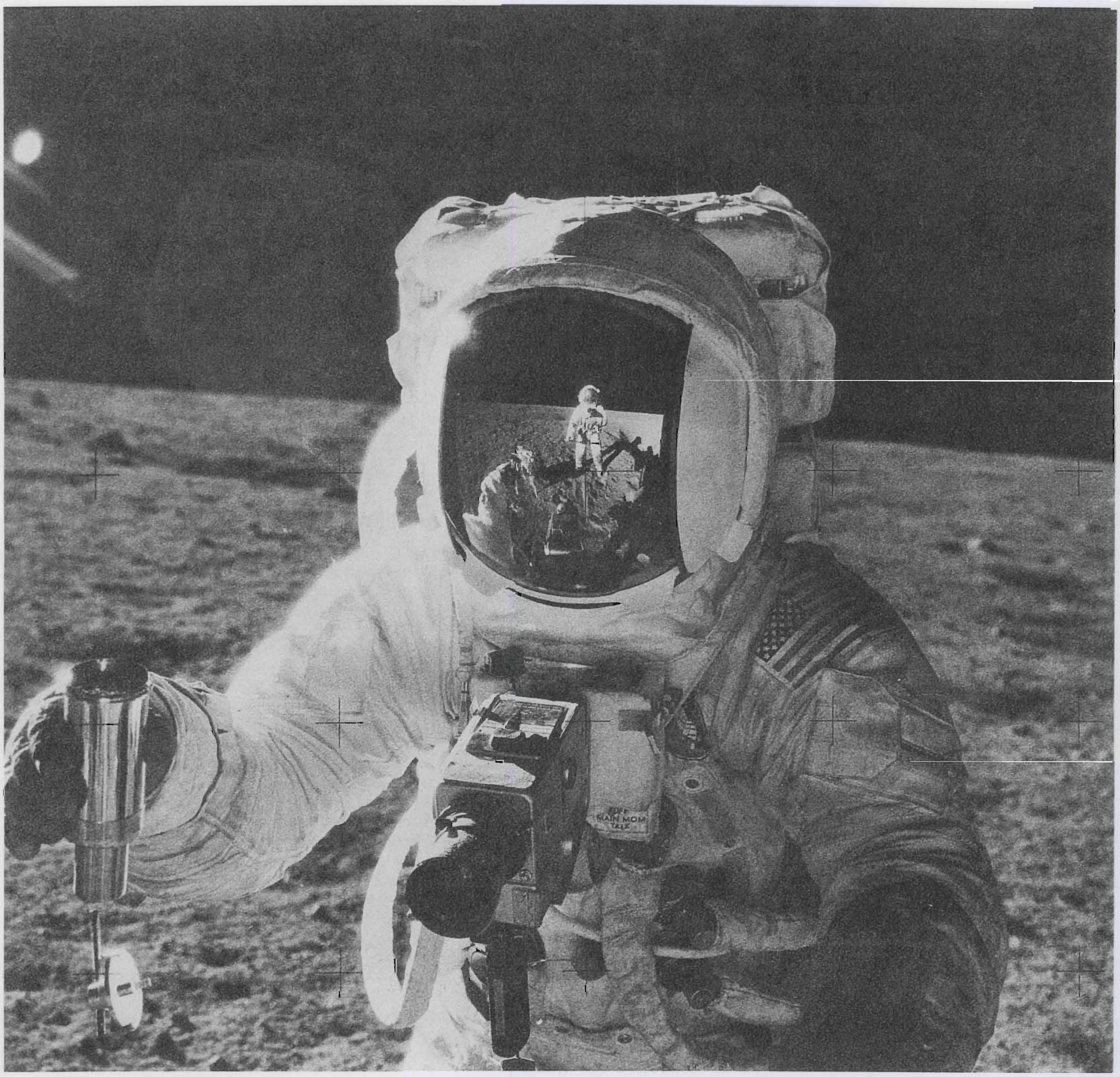
None of the animals that died during the Apollo 11 tests suffered any harm from the lunar dust. In fact, an untreated group of fish sustained the highest mortality rate. They were killed when a bottle of sodium hypochlorite (a disinfecting agent) was accidentally spilled, releasing fumes throughout the lab. Their tank happened to be located nearest to the lab's ventilation system, which spread the fumes. A few oysters also died because they fouled their own water.

After tests were completed, NASA scientists prepared microscopic slides of the animals' tissues. Professor Brooks was asked to examine histological sections of the cockroaches and determine whether any pathologic conditions were caused by the dust. She found no disease nor anything that looked faintly suspicious.

Most scientists involved in the lunar research program did not expect to find signs of life on the moon fragments. But this didn't mean that they weren't disappointed when their expectations were confirmed. One scientist hinted at finding "fossil-like" remains in his sample, but others were unanimous in declaring that there were no signs of life.

A microscopic view of moon dust and cells lining the cockroach's stomach. The particles of lunar dust are no larger than .00005 inches.





Apollo 12 astronaut Alan Bean gathered moon dust in a special metal receptacle for the journey back to Houston's Lunar Receiving Laboratory.

Professor Brooks found no microorganisms and doubts whether the moon is capable of sustaining any form of life since it has no atmosphere, no carbon, no oxygen, no nitrogen—none of the basic elements essential to life support.

The biggest surprise Dr. Brooks experienced during her microscopic studies was that lunar particles didn't damage the cockroaches' stomach cells. Even the insects' delicate cuticles were not broken from walking on the sand-like crystals. "We thought when the moon sample was ground up that there would be sharp, jagged edges. But there were no signs of abrasion or scratches."

Professor Brooks duplicated her Apollo 11 efforts on samples gathered by Apollo 12 and plans to take part in Apollo 13 experiments slated for May. Moon soil from the Apollo 13 landing site, the ancient Fra Mauro highlands, is expected to be as different as Apollo 11 samples were from those of Apollo 12.

In the meantime, she is teaching and has two research projects to occupy her attention. One project is devoted to developing living cell cultures, with an eye toward using these cultures as testing grounds for bacteria, fungi, viruses, and other disease-causing organisms of insects. Eventually Dr. Brooks' research team hopes to devise methods by which these organisms might be mass produced to fight the state's economically damaging crop and forest insects. □

Beef Futures Hedging

WHAT YOU NEED TO KNOW

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Changes in price levels often make cattle feeding a risky business. Between the time you purchase cattle and market them, your profits could be reduced by slumping prices.

Several times during the past few years prices received for slaughter cattle have been below many farmers' expectations. Many have incurred losses despite their technical and managerial know-how because they were unable to forecast the direction and amount of change in prices. Often, if they had known more about the live beef futures market, they could have protected themselves against unfavorable price changes.

The futures market deals with promises to deliver or receive a commodity at some future time. These promises are made in the form of a legal contract. Futures contracts are bought and sold on organized markets in much the same way that stocks and bonds are exchanged in the financial markets.

People who deal on the futures market are called "speculators" and "hedgers." Speculators are interested in dealing with the futures contract to make short-term financial gains as futures prices rise and fall. Speculators accept price risks. Hedgers are interested in selling a contract against an inventory of products they hold in order to avoid the risk of changing prices.

A cattle feeder becomes a hedger when, through his broker, he sells a futures contract that sets a price for his cattle, which he will market at a later date. The futures contract is a standardized agreement. It specifies the price, grade, quantity, place and time of delivery, and costs involved. The contract also lists quality substitutions that may be made.

Futures contract prices reflect supply and demand conditions in the Chicago area. Therefore, the Minnesota cattle feeder must adjust Chicago prices to compare them with prices at his location. Local Minnesota prices generally run lower than Chicago prices. So if a cattle feeder hedges some cattle in his feedlot by selling a futures contract, the "locked-in" price is not the Chicago price, but rather a "localized" price.

"Localizing" futures prices to reflect this price difference can be done in one of two ways. First, you can determine the price difference between your location and Chicago. Second, you can localize it by adding up all the costs of having the cattle delivered to Chicago.

Cattle feeders who establish a localized choice steer futures price by the second method should subtract transportation and marketing costs. Additional weight loss—shrinkage—should be calculated and added to transportation costs. Brokerage fees, shrinkage, and interest on the margin deposit should also be subtracted from the Chicago futures price to arrive at a localized price. Hedgers entering the futures market must pay brokers a fee, which is (in some cases) 9 cents per hundredweight or $36 per 40,000 pound contract on the futures market.

A margin deposit of approximately $450 is required for each contract bought or sold. Deposit requirements of individual brokers may be higher. Interest on the margin is what constitutes a cost to the hedger. The margin cost will vary depending on how long the money has been on deposit and what interest rate has been used. But it can be estimated at 8 cents per hundredweight. Cattle feeders who sell a contract may have to deposit additional funds if prices increase.

Once you have estimated when your cattle will be ready for market, you then know what futures contract month and what planning price to use. After localized costs are subtracted from the futures price, the cost of your feeders and feeding costs should be estimated to determine the outcome of your hedging operation.

The cattle feeder may decide whether to enter the futures market by comparing the estimated returns with and without a hedge. Cattle feeders could hedge if prices are expected to decline drastically, and if the futures contract price is higher than outlook forecasts indicate.

Futures contracts are different from other contracts since they can be fulfilled in two ways. They can be closed by either delivering the cattle in Chicago according to the contract, or by making an offsetting futures trade before the contract date. In the latter case, the hedger who sells a contract for delivery in October can offset his obligation to deliver his cattle by simply buying an October futures contract. In a sense, he buys back his contract, but not necessarily at the same price he sold it. The locked-in or hedged price will normally be almost the same under either hedge-lifting option, providing the localized price has been correctly calculated.

These two alternatives can be illustrated by the following situation. Suppose you calculate that you need $30 per hundredweight at market time next August to cover the original cost of some choice steer feeders plus all feedlot costs. You look at the Chicago choice steer futures market of $31 for August delivery. If the local finished choice steer price in your area normally runs $1 per hundredweight under the Chicago price, you calculate that your localized price would be $30.

When August arrives, you can either deliver the choice steers on the contract in Chicago or buy an offsetting Chicago option contract back when you sell your fed cattle.

Suppose Chicago cattle prices and Chicago futures prices are $2 per hundredweight under the price that the contract was sold for in January. If you select the first alternative, you pay the transportation costs plus additional marketing costs from your farm to the Chicago stockyards. If these costs are $1 per hundredweight, you net $30 per hundredweight—your aimed for locked-in price.

If you select the second alternative, you sell your cattle on the local market for $28—$1 under the Chicago cash and futures price—and realize $2 per hundred less than if you had delivered. However, since cash and futures prices generally move together, you can now buy a contract back for $29 per hundred which you originally sold for $31. In the process, you gain $2 on the futures market. The loss in this cash market from not delivering is offset by the gain in the futures market. The locked-in price still remains the $30 per hundredweight localized price.

However, cattle feeders must remember that the same hedge which protects against a loss also disallows a windfall profit. Suppose Chicago cash and Chicago futures prices are $33 per hundredweight or $2 per hundredweight over the price the contract was sold for in January. If you deliver, you'll have to do it at the contract price of $31, or at a net of $30 per hundredweight.

If you sell your cattle on the local market for $32, you net $2 more than if you had delivered. However, you must now buy back a contract which you originally sold for $31 per hundredweight at the price of $33, or at a loss of $2 on the futures market. Again, your losses and gains offset each other and the net locked-in price is $30 per hundredweight.

Hedges don't always work out as neatly as this illustration indicates. The major reason they don't is due to changes in the "basis"—the difference between local prices and Chicago futures. However, as a cattle feeder you can avoid problems by seeking the assistance of a knowledgeable broker. In addition to buying and selling contracts, a good broker will also serve as a consultant.

Cattle feeders should also consult and keep their bankers informed. Additional funds will be needed for the initial margin under a hedged operation. If the futures market price moves against the sale position, additional margin will be requested by the brokerage firm. But in a hedge position this should not be a problem. The loss is being offset by an increase in the value of the live animals since the futures and cash prices tend to move together. □

New Aspen Stud Marketed

A method of sawing marketable studs for home building from low-valued aspen trees has been developed by University Forest Products researchers. The 3-year research project proved that aspen studs can be manufactured and marketed. Robert D. Thompson, assistant professor of forest products, and research assistant Fred Hill developed the cutting and treating methods for the new aspen studs. Acceptance of the aspen stud by the construction industry and building codes could give northeastern Minnesota's timber economy a substantial boost. Aspen trees are mostly used for pulpwood in manufacturing paper, fiberboards, cardboard boxes, siding, wallboard, and other products. Although some mills have manufactured aspen studs, they were not accepted by builders due to aspen's tendency to warp.

In the past, timber shipped to Minnesota from the West Coast, such as Douglas fir, larch, white pine and white fir, was used for studs, rather than Minnesota-grown aspen. The state's total aspen pulpwood harvest is about a half-million cords a year, but aspen is growing faster than it is being cut. The aspen, sometimes called "popple," is undercut by more than 300,000 cords a year, according to a recent report from the University of Minnesota Agricultural Extension Service.

Aspen harvests could at least be doubled since many of these hardwood trees are going to waste, University experts say. Although the economic advantages of marketing aspen studs have not been determined at this time, Thompson believes there would be a regional market for the product. The aspen stud would present a cost advantage for Minnesota use and a good share of the product would be absorbed by the Chicago, Des Moines, and Kansas City markets.

The estimated cost for aspen logs runs $38 per 1,000 board feet compared to $100 per 1,000 board feet for softwood logs shipped in from the West Coast. Much of the price difference is due to savings from freight costs.

Forest product researchers say the next phase of the project will be to determine the economic advantages of producing and marketing aspen studs. If the aspen stud is successful, one mill could produce 12 million board feet of lumber each year. The Twin Cities area alone could supply a market for six or eight lumber mills. Aspen cutting would be increased, allowing the use of what is now considered an excess resource, Thompson says.

To test the marketability of the new studs, the forest products division distributed the products to individuals and businesses for remodeling and construction projects, mostly in the Twin Cities area.

A 12-unit dormitory at the Long Lake Conservation Camp near Aitken is being built with 13,218 of the studs. Pemtom, Inc. used aspen studs to build a home in Park Hills Addition near St. Paul. University researchers say they will check the new construction over a period of time to determine how the studs perform.

Using the method developed by Thompson and Hill, studs are sawed only from the outer part of the aspen so the grain is flat. A new saw on the market will produce four 2 by 4 studs and chips from each aspen log. □

Biological Control of Crop Disease

Farmers can increase both stands and yields of cereal crops through biological or cultural control methods that often have advantages over chemical controls, according to University of Minnesota plant pathologists. This is particularly true in years when environmental conditions favor root diseases: such as cool, wet springs for corn, or hot, dry conditions for small grains.

This conclusion is one of the results of research conducted by Thor Kommedahl, professor of plant pathology, and graduate students I-Pin Chang, R. F. Nyvall, and H. L. Warren, on the ecology of soil fungi and how it is related to root diseases of cereal crops.

Their research focused on controlling disease-producing (pathogenic) root fungi of cereal crops through biological and cultural rather than chemical means. Tests showed that pathogenic organisms on corn kernels can be controlled by coating the kernel with non-pathogenic organisms that crowd out the disease-causing organisms.

They found one fungus and one bacterium that, when placed on a corn kernel, would protect it from root disease for a month. Disease control occurs when the non-pathogenic organisms grow on the kernel and keep away the organisms that cause seedling blight.

The researchers also found that coating the seed influences other organisms around the roots. "Roots give off nutrients that attract organisms," Kommedahl says. "You can protect a plant from root diseases if you can change the ecology so the nutrients attract micro-organisms that are antagonistic toward the pathogenic organisms."

In many cases biological control has advantages over chemical control, Kommedahl says. For example, chemicals protect the kernel, but the roots eventually grow away from the area of protection. When the kernel is coated with non-pathogenic organisms, however, the organisms grow with the root, thus protecting a greater amount of the root system.

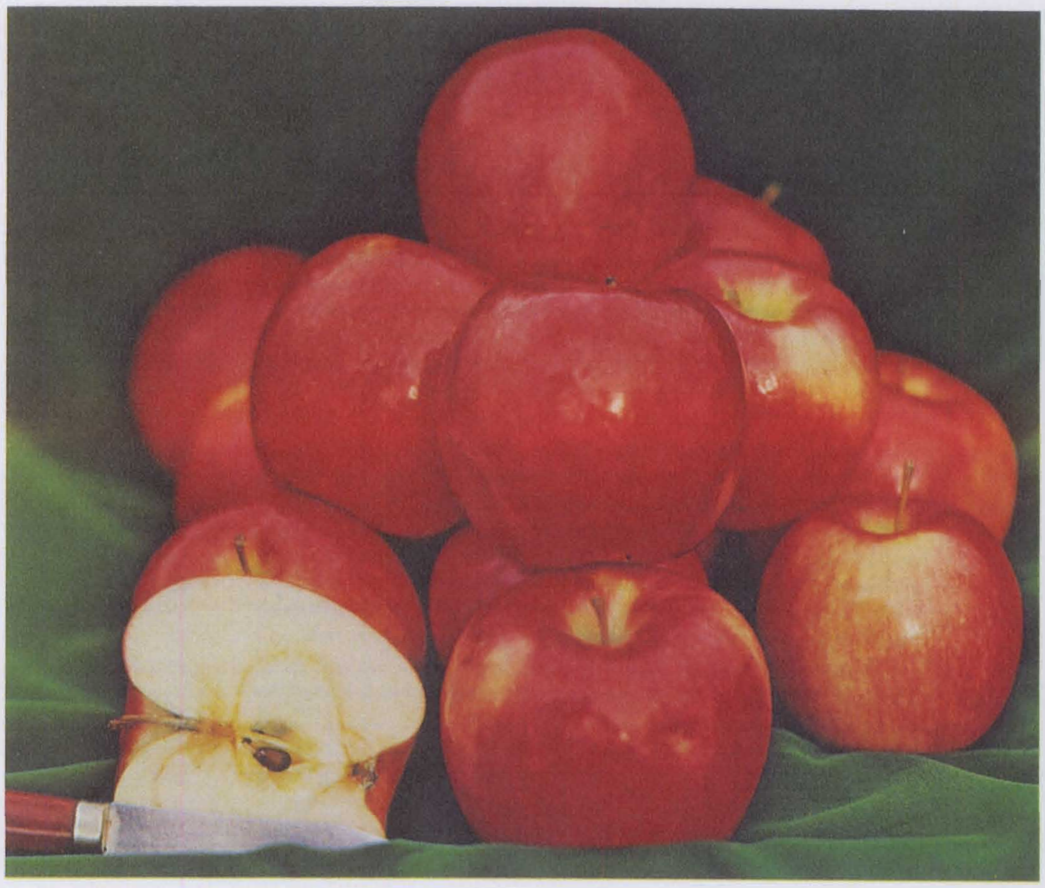
Kommedahl and Warren studied the effects that crop residues and fertilizers have on the survival of pathogenic organisms, and how root diseases can be reduced by altering these cultural practices. They found that the number of pathogens on roots of corn, oats, and soybeans becomes abnormally high if residues were removed and no fertilizer was added. But adding fertilizer to plowed-down residues helps to maintain a better balance of soil organisms. This better balance helps control pathogens.

If residues were plowed down but no fertilizer was added, or if residues were removed and fertilizer added, pathogen control was not as great as if both the residues were plowed down and fertilizer added.

Kommedahl and Nyvall found that some pathogenic organisms grow rapidly in the straw residues and quickly exclude other organisms that help maintain a balance. They also found that pathogenic organisms survive in old corn stalks that are plowed under. When new corn stalks grow through those plowed-under, the new stalks become infected. Pathogenic organisms do not survive as well when the stalks are left on the surface as when they are plowed under, Kommedahl says. "However, there are other good reasons for plowing under the residue. At this point we still need more research on biological control practices before we can apply all our findings to the farmer's benefit."

Kommedahl and his associates have been concentrating on a fungus species called *fusarium*, a major root disease organism of cereal crops. "Our two objectives," he said, "are to increase our knowledge of the ecology of root-infecting fungi, and to make information on biological control methods available to the farmer." □

Red Baron and Honeygold



RED BARON (above) was selected from progeny of a Golden Delicious by Daniels Red Duchess cross. This is an attractive cherry red apple that matures in Wealthy season at the Horticultural Research Center. The cross was made in 1926, and was selected as Minnesota 1500 in 1940 by W. H. Alderman.

Red Baron is a hardy, attractive, and consistently productive variety with good quality. It should provide an attractive apple for the Wealthy season. It keeps well in common storage until late December, but has been used primarily as a late summer or early fall apple. It has also rated consistently well as a pie and sauce apple.

Fruits are medium-size, usually three-quarters to fully colored with bright cherry red washed overcolor and yellow undercolor. Fruit shape is round-truncate and regular. There are many medium-size, round white dots, which are slightly raised. The stem is long and medium thick. The cavity is deep and acute, whereas the basin is deep, wide, and abrupt. The calyx lobes are closed and the calyx tube is conical. Stamens are basal. The skin is bright, glossy, medium thick, and tough. The flesh is crisp, juicy, bright, and pleasantly acid, but tends to oxidize when cut.

The attractiveness of the fruit, consistent productivity, moderate resistance to fire blight, and season of maturity make this a valuable addition to our apple varieties.

HONEYGOLD (see cover photo) was introduced to provide a Golden Delicious type of apple for Minnesota and other northern areas where Golden Delicious is marginally adapted. It resulted from a cross between Golden Delicious and Haralson made in 1935 and was selected as Minnesota 1595 in 1947 by W. H. Alderman.

Honeygold ripens during Haralson season at the Horticultural Research Center. This apple has consistently rated high in storage and pie evaluations. The flavor resembles Golden Delicious, and both flavor and quality persist well in common storage until the end of January.

Honeygold is susceptible to fire blight and should not be grown where this disease prevents Beacon from being grown. Fruits are medium to large, golden to yellow green, often with an attractive bronze to red blush. Fruit shape is round-conic and somewhat irregular. Dots are large, corky, conspicuous, usually triangular or stellate. The stem is long and slender. The cavity is acuminate and the basin is deeply lobed and abrupt. Calyx lobes are recurved and the calyx tube is conical. The stamens are median. The core is median, open, medium size with core lines clasping. The skin is smooth, thick, and tender. The flesh is crisp, yellow, juicy, and has a flavor similar to Golden Delicious.

Even though Honeygold is susceptible to fire blight, its fine dessert and cooking quality, combined with hardiness, should make it popular where Golden Delicious is marginal.

Winter and Minnesota's Moose

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What happens to the ungainly moose you surprised last summer in the lily pads when his lake becomes frozen over and the ground is buried under four feet of snow?

For years the answer to this and other questions concerning how moose survive in Minnesota's north country were largely unknown. But recent studies conducted by University wildlife specialists have shed considerable light on the different habitats moose seek out as the winter season progresses. Work reported here was carried out on a 756-square mile area in Lake County in northeast Minnesota during the winter of 1968-69.

Aerial observation in late November showed that moose preferred hardwood forest stands with a great deal of open area. Group sizes during this time were on the order of three moose, but a group of 15 moose was observed. Light snow cover gave the moose easy access to a variety of shrubs, and their diet consisted of willow, red osier dogwood, juneberry, and paper birch.

By mid-December, moose were still found in sparsely stocked stands of aspen and birch, though snow depths were no greater than 10 inches. However, the animals had become more dispersed. Group sizes dropped to an average of two moose and the largest group we observed consisted of seven bulls. Willow and red osier dogwood remained common items in their diets.

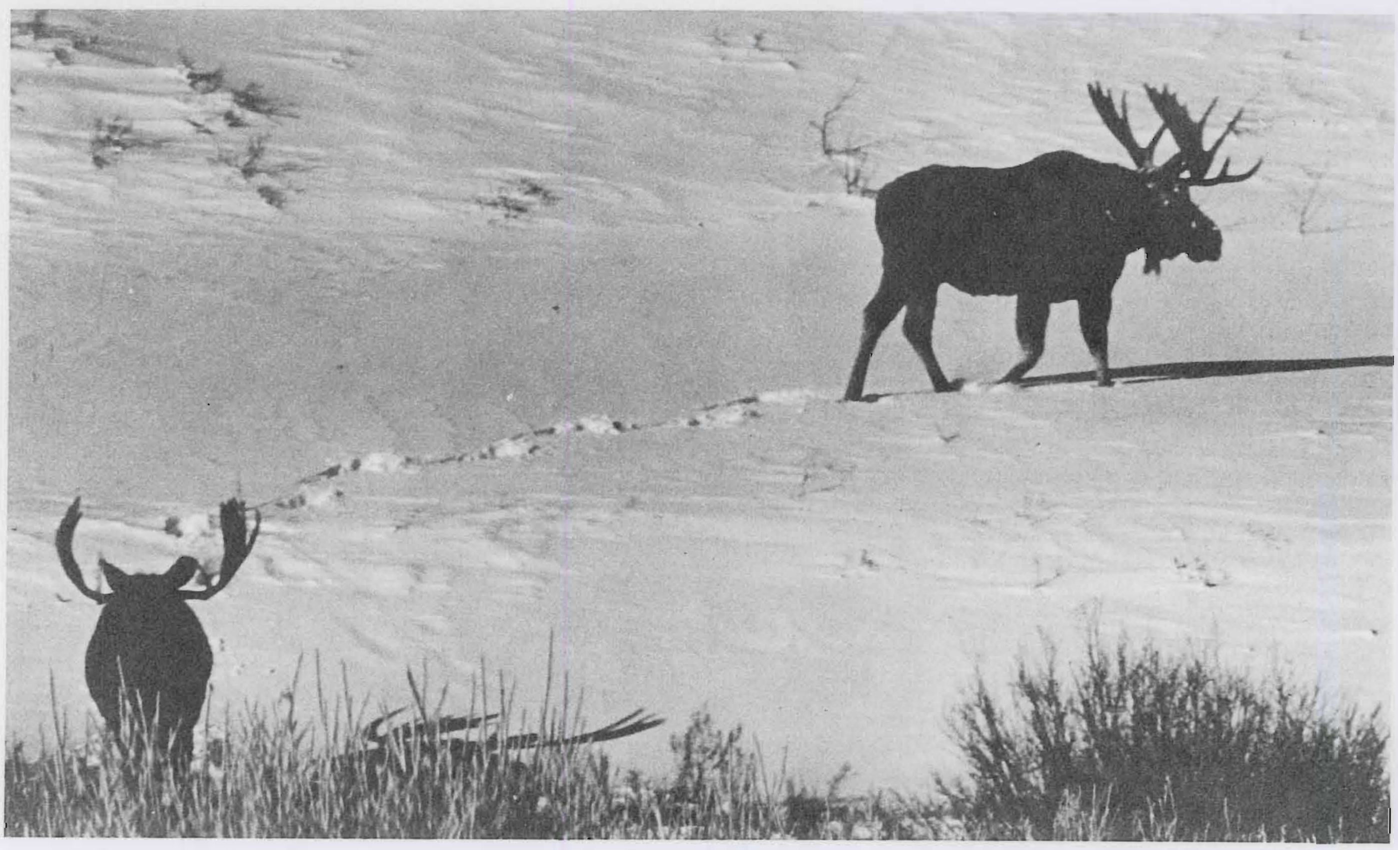
Deep snows in early January brought about a marked shift in the habitat sought by the moose. Snow depths of about 31 inches in open areas apparently forced the moose to seek better shelter in more densely forested areas—where trees were spaced between 10 to 20 feet apart. Individuals became even more dispersed and groups averaged slightly less than two moose. No groups with over three moose were found.

The change in habitat was also accompanied by a change in the moose's diet. Balsam fir became an important food item for the first time. Certain shrubs that are typical of more dense cover (especially beaked hazel) were sought out by the moose. Their move to dense cover hindered aerial observation after early January so we obtained our information by tracking them on snowshoes.

Midwinter Moose Habitat

In early February snow depths in open cover reached 45 inches, with depths as high as 58 inches. Group sizes continued to decline to about 1.5 moose per group. Their midwinter diet consisted of balsam fir, beaked hazel, moun-

Winter weather exerts a strong influence on the life of the moose. As snow becomes deeper and the temperature drops, he seeks out the more comfortable environment found in dense forest stands. The Minnesota moose study was carried out in Lake County.



tain maple, paper birch, and aspen. During this time the animals showed a preference for dense forest stands of balsam fir and white or black spruce. Snow depths in these dense stands were about 16 percent less than in open areas, which moose had commonly used earlier. We found that moose made a trench in the snow when moving about, and calves were confined to trails left behind by the cow. We were frequently able to snowshoe right up to moose in this deep snow.

Four moose that were collared with radio transmitters in January gave us the general pattern of their movements during this time. We found that the moose occupied very small areas for a week or so (in one case, almost a month) before moving. This pattern was repeated throughout the winter. Sometimes roads provided travel lanes for movements of several miles. Moose apparently do not "yard up" as deer do along the north shore of Lake Superior or in upper Wisconsin and Michigan. Instead, they move alone or in small groups and stick to dense spruce and fir cover on their range.

Finding A Comfortable Environment

Several reasons explain why moose moved into dense coniferous cover even if it was not the best foraging area on the range. First, snow depths are less because a portion of the snow is intercepted by the tree canopy and occurs as *kukhta* (snow retained on trees). Conifers are much more efficient than deciduous trees at intercepting snowfall. As a result, the *qanimiq* (a bowl-shaped depression in the snow) beneath a fir tree is larger and about 50 percent less deep than the rest of the stand. The *qanimiq* beneath a birch tree is much smaller and only 10 percent less deep.

During this snowy period the moose essentially moved from one *qanimiq* to another, spending much time near the base of fir trees. Here he fed upon the fir tree and shrubs that protruded through the snow. Often, these fir trees were heavily browsed to 10 feet or more above the ground.

Other snow characteristics also helped to explain why moose preferred dense cover. Moose were forced to wade through most of the snow profile rather than walk on part of it. The hard dense snow of open cover apparently made movement more difficult for the moose. Studies in northern Michigan have also shown that dense conifer cover has the warmest average temperature, the least amount of wind, and the highest and most stable relative humidity during the coldest weather.

Moose were unable to walk on the snow cover during February and the first 3 weeks of March. After that, the snow (especially in open cover) became sufficiently hard to support the moose. Tracks gradually appeared in the more open cover types, and the pattern of winter habitat use once again changed. Food habits reflected this change with an increase of willow and a decrease of fir.

Habitat Preference

Moose habitat selection depends upon a variety of environmental factors, which during the 1968-69 winter included an unusually deep snow cover. The habitat preferred by moose at one time was not preferred at another. However, preference is not synonymous with requirement. It is entirely possible that moose could occupy even the most open covers during the deepest snows and still survive well. In fact, moose do quite well in many parts of their range where no dense conifer trees and palatable balsam fir are present. But it appears that these characteristics play an important role in making a large part of the northeastern Minnesota study area a quality environment for moose. Also, serious overbrowsing, to the point where only a few abundant species make up the major dietary items throughout winter, has not yet been observed. The wide diversity of forest communities in many ages and heights present may be a significant aspect of quality moose habitat.

Determining the Future

Moose-winter habitat studies are vital to understanding moose ecology, but other studies in progress help round out a picture of the status and future of the moose population. Moose census, conducted over a period of years, will help to determine population characteristics and trends across the study area. Forage condition and utilization studies help determine the influence of moose upon their environment. A knowledge of natural forest community changes and timber management practices, past and present, help to evaluate how present habitats originated and how they will change. Wilderness management practices will also affect the moose population, and must be considered. Eventually all this information may be used to integrate a moose habitat management program into other forest uses. On this basis, a moose population may be maintained in harmony with other land uses for the benefit of future generations of Minnesotans. □

A midwinter aerial view of moose living within the refuge of a moderately dense conifer stand.

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