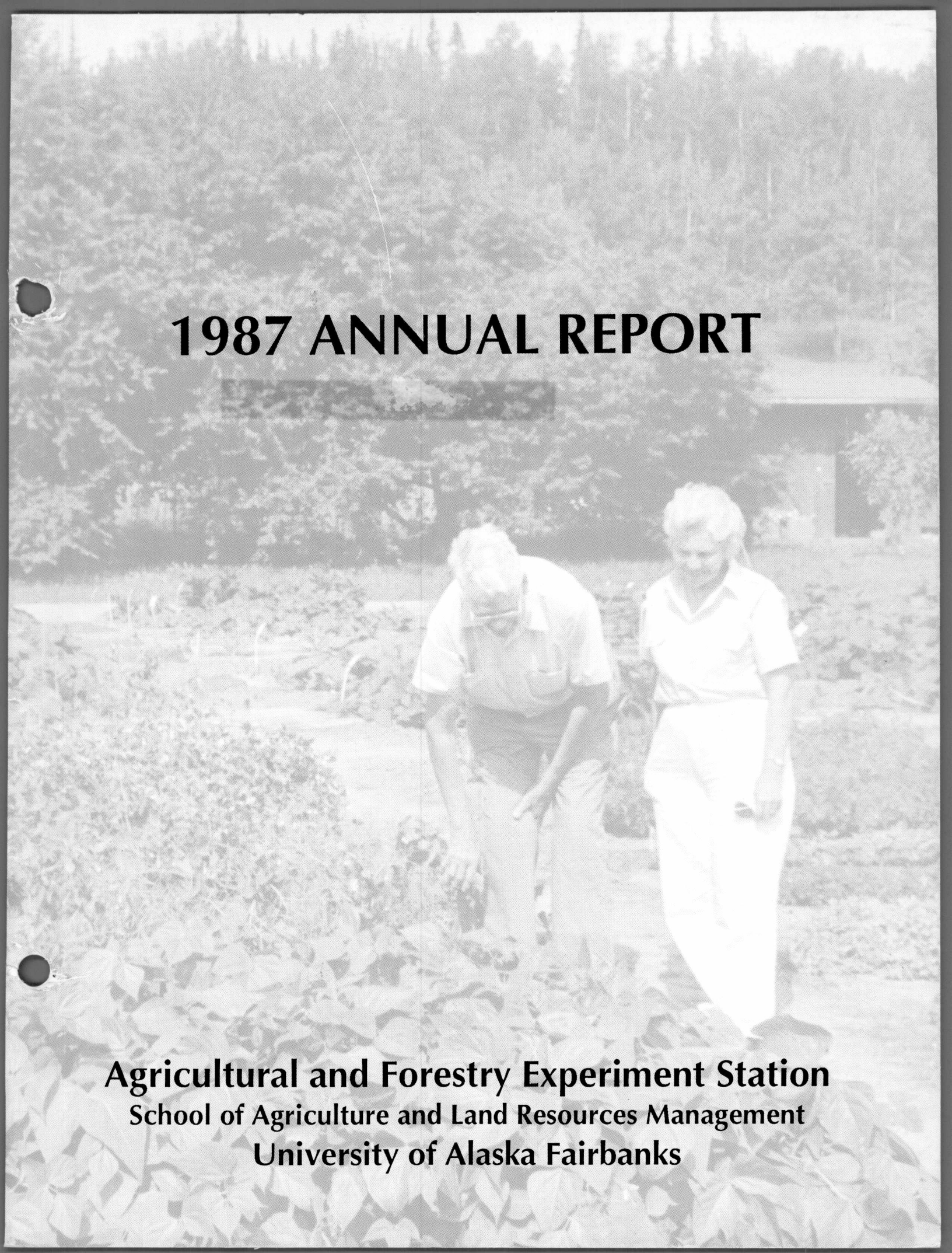
1987 ANNUAL REPORT



Agricultural and Forestry Experiment Station

School of Agriculture and Land Resources Management

University of Alaska Fairbanks

Cover: Thousands of summer visitors like Mr. and Mrs. John Belcher of Blue Hill, Maine, visit the display gardens at the Agricultural and Forestry Experiment Station's Experiment Farm each year. Such visitors are often astonished at the variety, size, and vigor of the many varieties of flowers, small fruits, and vegetables that can be grown in Alaska's interior. *(Cover photo by Charles W. Knight.)*

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University of Alaska, Fairbanks

"ANNUAL REPORT"

For the year ending December 31, 1987

Fairbanks, Alaska 99775-0080

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Letter of Transmittal

The Honorable Steve Cowper
Governor of Alaska
Juneau, Alaska 99811

Dear Sir:

I submit herewith the annual report of the Agricultural and Forestry Experiment Station, School of Agriculture and Land Resources Management, University of Alaska Fairbanks, for the period ending December 31, 1987. This is done in accordance with an act of the Congress, approved March 2, 1887, entitled "An act to establish Agricultural Experiment Stations, in connection with the Agricultural Colleges established in the several states under the provisions of an act approved July 2, 1862, and under the acts supplementary thereto," and also of the act of the Alaska Territorial Legislature, approved March 12, 1935, accepting the provisions of the act of Congress.

Very respectfully,

James V. Drew
Director

Fairbanks, Alaska
June 30, 1988

Contents

Statement of Purpose

The purpose of this report is to summarize progress in research projects at the Agricultural and Forestry Station (AFES). These projects are designed to provide research results for the development and conservation of land resources in Alaska.

Specifically, the research objective of AFES is to provide new information for use in: (1) increasing the efficiency of production systems for food and wood products; (2) improving processing and marketing for Alaska's food and wood products; (3) improving resource inventories and land-use planning for agriculture and forestry; and (4) developing resources management for improving the quality of life, including revegetation procedures, pollution control, landscaping and home gardening, and outdoor recreation. Results from this research are used by farmers, foresters, land managers, and the public at large which benefits from the use of land resources.

In identifying local research needs in Alaska, scientists from the experiment station meet annually with farmers, foresters, and land managers from various regions of the state to discuss research needs. In addition, experiment station scientists receive requests for research information through extension personnel who have day-to-day contact with farmers, foresters, and land managers. Moreover, experiment station scientists present talks at farm forums, agricultural field days, greenhouse workshops, vegetable conferences, reindeer herder workshops, and forestry workshops and receive information about research needs during these meetings. In the resources management areas, experiment station scientists meet regularly with agency personnel to discuss research needs; experiment station scientists also participate on advisory panels for land management agencies.

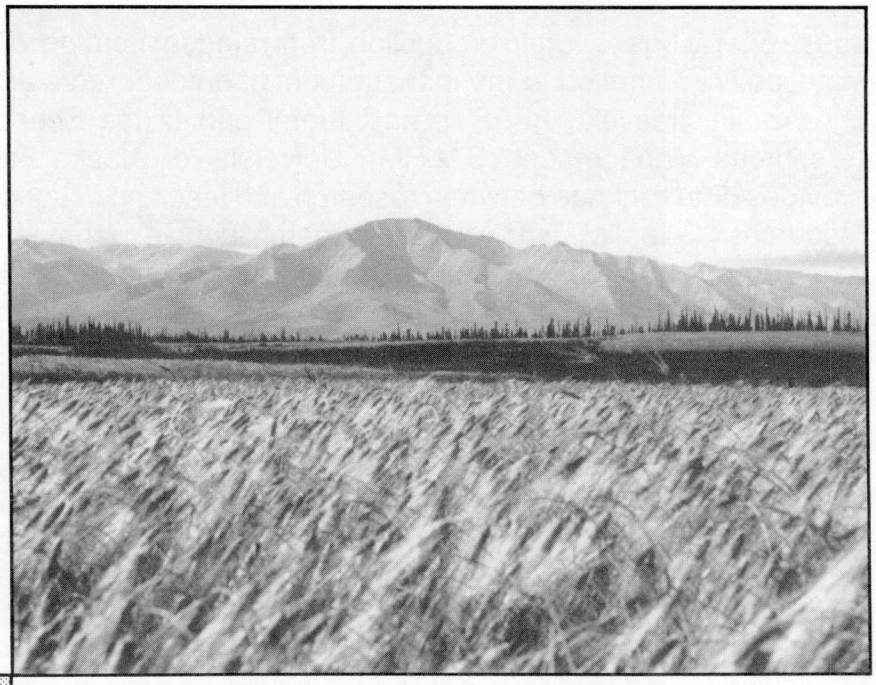
Thus, most of the research described in the plant and animal sciences section of this report was initiated on the basis of requests from producers. Moreover, a number of the research projects described in the forest sciences section and the resources management section were also initiated on the basis of requests from producers. The remaining projects in these sections were developed from requests by state or Federal agencies for research information needed to carry out specific agency missions.

Research completed at AFES is published in scientific journals as well as in experiment bulletins, circulars, conference proceedings, books, and in the station's journal, *Agroborealis.* Scientists at the experiment station also participate frequently in conferences, workshops, and other public information programs involving subjects ranging from green-

house operations to potato production, from reindeer herding to forest productivity, and from minespoil reclamation to the management of outdoor recreation.

Administratively, AFES is an integral part of the School of Agriculture and Land Resources Management (SALRM), University of Alaska Fairbanks. This association provides direct linkage between research and teaching in agriculture, forestry, and natural resources. Scientists who conduct research at the experiment station also teach courses, present seminars, conduct field trips, and advise undergraduate and graduate students. Thus, students receive the latest information and skills from the researchers who are perfecting them.

This annual report is divided into three major sections: Plant and Animal Sciences, Forest Sciences, and Resources Management. Each section provides summaries of research projects underway at AFES. The report concludes with a list of all publications for 1987, a presentation of the faculty and professional staff for SALRM, and a financial statement.



Disease resistance, high yields,and adaptation are among the most important factors sought by cereal breeders at the Agricultural and Forestry Experiment Station as they strive to provide Alaskans with lines suited to our unique growing situation.

Plant and Animal Sciences

Cereal Breeding and Production

The current barley-breeding program was expanded during 1987 with the addition of selections possessing disease resistance and some measure of adaptation. Barley-breeding progress has been accelerated through the use of a winter field nursery in Arizona. Success of this first winter crossing nursery, where twenty-one barley hybrids were produced, prompted the continuation of this effort, and twenty crosses are planned on material planted in November. Performance data concerning some one thousand barley lines were summarized, with selections made for the establishment of separate breeding programs for six-row, two-row, hooded, and naked kernel materials. Favorable characteristics selected for inclusion in each crossing program included high yield, early maturity, strong straw, high protein content, disease resistance, large heads, large kernels, and heavy tiller production.

About two hundred fifty oat, two hundred fifty wheat, and five hundred barley lines received detailed performance evaluation at Palmer. These included the most promising selections from past breeding efforts, disease-resistant selections, and materials recently obtained from Norway, Finland, and Sweden. Above-average barley yields were obtained in response to favorable moisture availability, although maturity was somewhat delayed by cool temperatures. Oat and wheat yields tended to be below average due to lodging and shattering caused by high winds in early September and to slow ripening. Disease evaluation of barley at Delta demonstrated that excellent resistance to current populations of barley stripe, scald, spot blotch, and net blotch is available in breeding materials. Oat forage yields at Palmer were considerably above average, exceeding four tons dry matters per acre. Alaska and Canadian materials continued to exhibit superior performance over varieties from more southerly locations. Hooded barley forage yield performance was comparable to oats.

Limited quantities of seed of most released varieties remain available. Pure seed increases were completed on two barley and two oat

varieties, as well as one each of new selections of barley, wheat, and oats. *R. L. Taylor.*

Snow Mold Disease Research

Sclerotinia borealis, a low temperature-tolerant, soil-borne, plant-pathogenic fungus, causes serious snow mold disease on winter cereals and grasses in regions at northern latitudes. Contrary to other findings, myceliogenic germination of sclerotia was found to be the primary source of infection in interior Alaska. No carpogenic germination of sclerotia was ever observed in field surveys conducted since 1980. In contrast, myceliogenic germination was observed frequently. Under moist conditions, tufts of mycelia were seen emerging through the nicks and cracks of the rind under scanning and light microscopy. Intact sclerotia remained inert until wounded. No exgeneous nutrients seemed necessary for myceliogenic germination. Pathogenicity of vegetative hyphae of *S. borealis* on winter wheat has been examined. Mycelia were found entering host plants mostly through stomata, but direct penetration through the cuticle has also been observed. Both cellulytic and pecteolytic enzymes were detected in the culture filtrates of *S. borealis*. These extracellular enzymes appeared to play a significant role in the rapid degradation of host tissues.

Enzymes produced by sclerotial low-temperature basidiomycete (sLTB) and *S. borealis* were concentrated by adding acetone to culture filtrates, collecting the precipitate after centrifugation (20,000 g, 20 min.), and resuspending the pellets in an acetate buffer. Activities were assayed on agarose diffusion plates which were stained with Congo red and ruthenium red to detect the activities of cellulases and pectinases, respectively. Approximate molecular weights (MW) of enzymes were estimated by gel filtration. sLTB produced three molecules (3.9, 5.2, and 7.1 x 10^4 MW), and *S. borealis* produced one (7.9 x 10^4) showing cellulytic activities. Pecteolytic enzymes from sLTB had a 5.8 x 10^4 MW, and those from *S. borealis* were 4.3 and 6.0 x 10^4 MW. Combinations of cellulytic enzymes produced by sLTB increased intensity of activities, but combining pectinases produced by *S. borealis* had no synergistic effect. *J. H. McBeath and F. Mehdizadegan.*

Biological Suppression of Snow Mold and Other Soil-Borne Plant Pathogens

In 1985, isolation of natural antagonists of snow mold fungi from the Alaska environment was initiated in an attempt to find alternative means to control snow mold disease. In 1986, an unusual fungus, CHS 861, was isolated from soils near Fairbanks, in interior Alaska. This isolate displayed marked tolerance to low temperatures. At 7 degrees Celsius, colonies reached 9 cm in 9 days. At 4 degrees Celsius, the colonies grew much slower (still faster than snow mold fungi), but they were well established and appeared normal. The pH for growth of the CHS 861 ranged from 1.5–9.5, with an optimum at 2.5–5.5. This isolate appeared to be a mycoparasite. Penetration of CHS 861 hypha into those of sclerotial low-temperature basidiomycete (sLTB) and the perforation of sLTB mycelia associated with CHS 861 infection have also been observed by light and scanning electron microscopy. In addition to snow mold fungi (e.g., *Sclerotinia borealis*, sLTB, *Fusarium nivale, Typhula incarnata, T. idahoensis, T. ishikariensis*), CHS 861 also was found to be effective in controlling *Armillaria mellea* and *Rhizoctonia solani.*

Several fungicide resistant biotypes of CHS 861 were also obtained recently by UV irradiation. The biotypes maintained all characteristics of CHS 861, but they were found to be highly resistant to Benomyl. Patent applications are currently being processed for both CHS 861 and its Benomyl-resistant biotype. *J. H. McBeath.*

Anther Culture and Snow Mold Resistance of Winter Wheat

In collaboration with Dr. G. Schaeffer at the Plant Molecular Genetics Laboratory, USDA-ARS, Beltsville Agricultural Research Center, a technique has been developed to obtain androgenic haploid plants from anthers of cold-hardy, early-maturing, hard red winter wheat. Concerted efforts are now being made to develop methods to screen and select calli and plantlets initiated from anther culture of these wheat cultivars for snow mold resistance. The long-range goal is to provide a means by which tolerance to snow mold in winter wheat cultivars can be expanded.

Calli initiated from anther cultures of 'Capitan', 'Froid' and 'Roughrider' were used to test their tolerance to *S. borealis* and sclerotial low-temperature basidiomycete (sLTB). Calli were weighed and inoculated with either the hypha of snow mold fungi or with partially purified enzyme preparations of these snow molds. After incubation at 10 and 20 degrees Celsius for 2 weeks, responses of calli to treatments were assessed. Discoloration was observed on calli of all three cultivars 8 days after enzyme treatment, however, no weight loss on any calli was detected. Discoloration was also observed on calli 9 to 11 days after inoculation of *S. borealis* and sLTB. Both *S. borealis* and sLTB grew very well on the calli of Roughrider, but their growth and development were found restricted when grown on the calli of Capitan and Froid. A direct correlation was found between the intensity of callus discoloration and the suppression of colonization of snow mold fungi on calli. *J. H. McBeath and F. Mehdizadegan.*

Method for Screening Bacterial Mosaic in Wheat Seed Lots

Bacterial mosaic disease was first diagnosed in Alaska on spring wheat and triticale in 1980. These diseased plants displayed a characteristic mosaic symptom on the leaf blades and sheaths closely resembling those caused by viral diseases or nutrient deficiencies. A gram-positive, rod-shaped nonmotile bacterium, identified as *Corynebacterium michiganese* ssp. *tessellarius*, was found to be the causal agent of this disease.

This disease has been found to be transmitted mainly through contaminated seeds. Scanning electron microscopy (SEM) of the seeds revealed the presence of clusters of bacteria on the seedcoat as well as in the seed coat-endosperm interface near the embryo, which makes the elimination of the bacterium from the seed extremely difficult.

A method has been developed to screen wheat germplasm for *C. michiganese* ssp. *tessellarius* in the seed lot. One hundred eighty three wheat cultivars and breeding lines were obtained from Dr. Lee Jackson, Department of Agronomy and Range Science, University of California at Davis. From each seed lot, thirty-two seeds were sampled. They were individually surface sterilized for 2 minutes in 0.5 percent Clorox, rinsed and soaked in sterile, distilled water at room temperature for 12 hours. The seeds were then cut longitudinally, and one of the halves was placed cut-faced down on a CNS selective medium. Orange-colored colonies of

C. *michiganese* ssp. *tessellarius* were observed around the seed halves after a 10-day incubation at 20 degrees Celsius. Presence of this bacterium has been detected in both common and durum wheat germplasm. Of the seed lots tested, one hundred thirty seven (75 percent) were found to be contaminated. This bacterium was detected in very high frequencies in thirty-two seed lots. The study indicates that this little-studied disease may be more widespread and economically important than has been generally suspected. *J. H. McBeath.*

Conservation Tillage and Residue Management

The silt-loam soils of Alaska's interior, the major area used for small-grain production, are highly susceptible to erosion by wind. Conservation tillage is an erosion-control method which has proved effective when used in the production of small grains. Problems addressed by this technique of crop management are:

- a short growing season,
- cool soils,
- marginal soil-water availability early in the growing season,
- control of weeds and diseases.

This research addresses the management of crop residues and tillage and seeding techniques in the production of barley in a continuous rotation. The research design initiated in 1983 includes three residue treatments: all crop surface residue and stubble removed, only surface residue removed with stubble left standing, and no residue or stubble removed. There are four tillage systems: no tillage, disk in the spring, chisel in the fall followed by harrowing in the spring, and disk in the spring and fall. Through the 1986 season, two types of planters were used on all tillage treatments: a double-disk, press-wheel drill which causes virtually no soil disturbance and a hoe drill which has a ridge-furrow effect. A disker seeder which operates similar to a disk is used only on the no-tillage and chiseled plots. In 1987, only the double-disk, press wheel was used. The parameters measured in each year of the study (other than grain yield and grain moisture) are soil and air temperatures, wind speed, relative humidity, rainfall, solar budget, soil moisture, soil fertility, and surface crop residues. Snow-depth measurements have been recorded in alternate years. Germination counts and plant dry matter at five stages of growth were also recorded during three years of the study.

Tillage and residue management techniques affect soil temperatures early in the season just prior to tillage and seeding in mid- to late May. In all years of the study, the no-tillage plots are thawed to a depth of 6 inches, while the tilled plots are still frozen at the surface. Stubble left on the untilled plots through the winter retains snow; the tilled plots do not retain snow. The loose soil and rough clods dry during the winter, and the dust mulch formed apparently does not allow a sufficient transfer of heat for rapid thawing to occur. This difference, however, is rapidly mitigated. Temperatures in all treatments remain below 50 degrees Fahrenheit at the seeding depth of 2 inches until mid-June. This is also a period of low soil moisture, and crop development is slow. Soils warm to 60 degrees Fahrenheit by mid-July when crops begin to head.

Analysis of variance in 1983 indicated no significant differences in yields or grain moisture for any of the treatments. In 1984, 1985, and 1986, the interaction of tillage and seeders significantly affected yields at the .01 level. The tillage-seeder interaction is most likely caused by the opposing performance of the tilling drills and the double-disk, press-wheel drill, which has no tilling action. Highest yields for these years were

obtained when the chisel treatment was used in combination with the double-disk, press-wheel drill (2,506 pounds per acre). No-till treatments with all seeders yielded lowest with an average of 1,610 pounds per acre. In 1987, only the double-disk, press-wheel drill was used. Performance of the hoe drill and the disker seeder had been erratic throughout the past years. Neither tillage nor residue treatment in 1987 affected barley yield or quality. Barley yields from plots chiseled in the fall and harrowed in spring were highest, at 3,143 pounds per acre. Yields from no-till plots were lowest at 2,385 pounds per acre. The low yields are attributed to infestation of native perennial grasses. *C. Lewis, R. F. Cullum, and B. J. Pierson*

Fertilizer Management in Reduced-Tillage Systems

A general rule which has emerged from research in temperate latitudes is that banding more than 120 pounds per acre of the full nutrient requirement for small grains with the seed has resulted in yield reductions. This has not been found to be the case in the subarctic. A 3-year study began in 1985 on ground which had been cropped to barley during the two previous years. Two types of complete fertilizer blends and four banding/broadcast ratios are used in the research. Both fertilizers have a nutrient ratio of 20-10-10-6 (nitrogen, phosphorus as $P_2 0_5$, potassium as K_2O, and sulfur, respectively). One is a complete-pellet formulation with ammonium nitrate as the N source. The other is a locally blended fertilizer with urea as the major N source. All plots in the study receive the same amount of fertilizer, a total of 400 pounds of material. Material is applied in four treatments: 100 percent banded, 70 percent banded, 40 percent banded, and 0 percent banded. The remainder is broadcast prior to seeding. In 1985, 1986, and 1987, yields increased significantly as a higher percentage of fertilizer was banded with the seed. In 1985, a significant difference was found in yields for the two types of fertilizer used for all banding/broadcast ratios with the complete pellet resulting in the best yield performance. In both 1986 and 1987, type of fertilizer did not significantly affect yields. *C. E. Lewis and B. J. Pierson.*

Barley Yield and Quality as Affected by Planting Date and N Rate

A study to determine how high rates of nitrogen (N) affect barley yield and quality as well as net returns to the producer when the crop is seeded beginning in early May through mid-June was begun in 1987. First-year results indicate that highest yields and highest net returns were realized at the early seeding date (May 7) and the highest N rate (120 pounds per acre). It is not always possible for farmers in the subarctic to plant this early. Therefore, it is interesting to note that grain seeded on May 25 brought the highest returns at an N rate of 65 pounds per acre followed by highest returns from grain seeded on June 15 using an N rate of 40 pounds per acre. A follow-up to the work completed in 1987 will be a consideration of protein quality of grain grown under the various treatment conditions. *C. W. Knight, C. E. Lewis, and B. J. Pierson.*

Tillage Energy Requirements in Interior Alaska

A John Deere 4030 agricultural tractor was successfully instrumented and used to pull several tillage implements in a conservation-tillage experiment in interior Alaska. The following tractor performance parameters were measured: drawbar pull, true ground speed, fuel consumption, and wheel slippage; fuel and air temperatures were also monitored. The tractor data acquisition system, based around a 21-X datalogger, provided accurate and reliable results. The drawbar dynamometer proved to be an effective means of measuring the draft of drawn implements. Draft and fuel-consumption data were gathered for tillage and seeding implements operating in the soil conditions of interior Alaska. The implements were tandem disk, hoe drill, banding disk drill, double-disk drill, one-way drill, packer, and chisel plow. Draft data were compared with data from ASAE Standards and data reported by researchers in other areas of Canada and the US.

Draft predictions based on the equations in ASAE D230.4 would, in most cases, give acceptable results for silt-loam soils in interior Alaska. Draft was generally higher in stubble conditions than on bare ground. Soil-moisture content was found to have the greatest effect on draft and fuel consumption. Speed was significant for several cases within each year when variations in soil moisture were minimal. *R. F. Cullum and W. D. Graham.*

Effects of Clearing, Tillage, and Management of Crop Residue on Soil Microbial Activityand Mineralization of N and P

Soil microbial biomass and soil enzyme activities were found to be lower in agricultural land near Delta Junction, Alaska, than in adjacent forest land. No differences were found due to long-term conventional tillage or no tillage. Straw-decomposition studies conducted in adjacent fields showed that 10-30 percent of barley straw decomposed on the soil surface compared with 30-50 percent loss when incorporated. With either system, there was a gradual build up of crop residues when continually cropped to barley. However, it occurred much faster with no tillage. Field studies at Delta also revealed that 70 pounds nitrogen (N) per acre, or about one-half the N required by a 60 bushel-per-acre barley crop, will be mineralized from the soil the first year after a barley crop. The other one-half must be supplied by other means. A comparison of mineral and organic phosphorus (P) in forest soil, cleared idle soil, or soil from a farmed field indicates a rapid mineralization of the organic P after clearing. Additional P was mineralized when the cleared soil was farmed.

Two laboratory studies were used to evaluate the potential availability of the organic N and P in the moss layer from a nearby forest soil, typically removed during the clearing operations. These studies showed that the moss layer mineralized considerably more N and P on a weight basis than did the agricultural soils. Therefore, we conclude that much of the macro nutrients held in the organic form in this layer would be available to crops within two to three years if this material were not removed during the clearing operation. *V. L. Cochran, S. D. Sparrow, and E. B. Sparrow.*

Crop Uptake of Residual Fertilizer Nitrogen

Results from a recently completed field study indicate that about 40 percent of the nitrogen (N) applied as urea at a rate of 90 pounds per acre to an interior Alaska soil is taken up by barley during the year of application and that approximately 40 percent of the applied fertilizer remains in the soil at the end of the growing season, most of it immobilized into organic forms. Studies in temperate zones have shown that small amounts of residual, immobilized fertilizer N is remineralized during years succeeding the initial application and that measurable crop uptake of the residual fertilizer N can continue for at least five years. The long-term fate of fertilizer N has not been studied in subarctic agricultural soils. This study is measuring the uptake of residual fertilizer N by barley plants in years following application. Nitrogen labelled N-15 is being used to trace the fertilizer N. Plant and soil samples are now being analyzed for N-15 by a commercial laboratory, but no results are yet available. This study will add to the understanding of N cycling in a subarctic agricultural soil. This, in turn, will lead to more efficient systems for N management. *S. D. Sparrow and C. W. Knight.*

Potato Yield Trials

Irrigated and nonirrigated yield trials with thirty-six named cultivars or numbered selections of potato were conducted in 1987. 'Green Mountain' topped all other cultivars yielding 12.4 and 15.5 tons per acre US #1 tubers in nonirrigated and irrigated trials respectively. Top total yield in the nonirrigated trials was achieved by var. 'Kennebec' (14.3 tons per acre) and in irrigated trials by var. 'Caribe' (18.5 tons per acre). Among varieties, average percentage of US #1 tubers was higher than in 1986, while average specific gravity was somewhat lower. Other varieties yielding well in nonirrigated trials include 'Shepody', 'Acadia Russet', and 'Rosa'; in the irrigated trial 'Superior', 'Bakeking' and 'Rosa' did well. A numbered selection (6-78-139-80), from the collection of Dr. C.H. Dearborn, did well in both trials. A detailed account of the 1987 potato yield trials is available from the Agricultural and Forestry Experiment Station. *D. E. Carling.*

Evaluation of Isolates of *Rhizoctonia solani* Recovered from Potato Plants and Potato Field Soil

Isolates of *Rhizoctonia solani* AG-3 recovered from soil in which potatoes were growing (directly on KHP medium or indirectly on beet seeds), stem lesions, tuber-borne sclerotia, and hymenia on aerial stems were evaluated for pathogenicity on developing potato sprouts (var. 'Bakeking'). Isolates collected from soils supporting different crops (including potato, carrot, barley, and bluegrass) as well as fallow soils were also included in this comparison. No clear differences were observed among the isolates tested as all were moderately to highly pathogenic. Colonial characteristics of isolates varied from dark brown to light brown in color, floccose to flat, heavily sclerotial to minimally sclerotial.

Pathogenicity determinations are being repeated on several potato varieties, including Bakeking, 'Russet Burbank', 'Alaska 114', and 'Alaska Red'. Identification of resistant varieties or avirulant isolates may result in better control of this disease. *D. E. Carling.*

Effect of Seed-Borne Inoculum of *Rhizoctonia solani* on Potato Growth and Yield

As in 1986, a field plot free of *Rhizoctonia solani* AG-3 was selected as a site to test the effects of seed-borne inoculum of *R. solani* AG-3 on potato plant development, yield, and disease symptom development. Seed pieces contaminated (less than 5 percent cover by sclerotia) or not contaminated with sclerotia of *R. solani* AG-3, were either dipped or not in a 1.85 percent aqueous solution of formaldehyde. Six weeks after planting, 20.5 percent of the contaminated seed pieces had not emerged, compared to 0.0 percent of the noncontaminated seed. By harvest, all but 3.4 percent of contaminated seeds had emerged, but the delayed emergence contributed to yield reductions. At harvest time, 90.9 percent of the plants developed from *R. solani* contaminated, nondipped seed bore evidence of necrotic lesions on subterranean stems; compared to 7.9 percent on all other treatments. Necrotic lesions formed on the aerial stems of 56.8 percent of the contaminated, nondipped treatment compared with 1.1 percent of all other treatments. The number of stems was not consistently affected by *R. solani*, and the presence of aerial tubers or hymenia was not an always-reliable indication of rhizoctonia disease. Other types of *R. solani*, including AG-2-1 and AG-9, also form hymenia on stems, without causing significant damage. The use of contaminated seed reduced yields by 39.2, 14.4, 72.7, and 69.6 percents in 'Alaska 114', 'Bakeking', 'Kennebec', and 'Superior', respectively. It is clear from these data that relatively small amounts of seedborne inoculum can cause large yield reductions in plots otherwise free of *R. solani* AG-3 and that formaldehyde dips can reduce, though not eliminate, disease damage. *D. E. Carling.*

In vitro Sensitivity of *Rhizoctonia* Species to Selected Fungicides

Isolates of *Rhizoctonia* and *Rhizoctonia*-like fungi were tested in vitro for sensitivity to the fungicides hexaconazole, iprodione, PCNB, benomyl, and prochloraz. A total of fifty-seven isolates, including *Thanatephorus* sp. (two or more isolates of each known anastomosis groups of *Rhizoctonia solani*), *Waitea* sp. (including isolates of *R. zeae* and *R. oryzae*) and *Ceratobasidium* sp. were studied. EC_{50} values for hexaconazole ranged from <.01-.12 milligrams a.i./L and were lower on average than such values for any other chemical tested. Hexaconazole was equally effective in vitro against isolates of *Thanatephorus*, *Waitea*, and *Ceratobasidium*. Iprodione and benomyl were moderately effective against isolates of *Thanatephorus* and *Ceratobasidium*, but generally ineffective against isolates of *Waitea*. PCNB and prochloraz were moderately effective against all isolates. Hexaconazole currently is not labeled for use in the United States. These data indicate a high level of sensitivity of all *rhizoctonia* isolates to hexaconazole. Upon labeling, this compound may prove to be of value in control of various diseases caused by *Rhizoctonia* and *Rhizoctonia*-like fungi. In other states hexaconazole has been effective in the field against diseases induced by *Rhizoctonia* sp. It may also be effective against diseases of potato and vegetables in Alaska. *D.E. Carling.*

The Effect of Different Crops on Soil-Borne Populations of *Rhizoctonia solani* AG-3

Plots inoculated with *Rhizoctonia solani* AG-3 in 1984 have been planted to six treatments, one of five crops or fallow, each season since 1984. The five crops include: 1) potato contaminated with *R. solani*, 2) potato free of *R. solani*, 3) carrot, 4) bluegrass, and 5) barley. The presence of potato plants, from contaminated or noncontaminated seed has resulted in soil populations of *R. solani* ten or more times greater than when crops other than potato are grown. Although recovery varies widely from harvest to harvest, we can conclude that, when potatoes are not grown on a plot, *R. solani* AG-3 populations tend to decline rapidly. This study will permit determination of a rotation crop and cycle suitable for minimizing losses to this disease. *D. E. Carling.*

Cultural Practices for Field-Grown Lettuce

Studies with 'Salinas' head lettuce again demonstrated harvest date can be advanced by 2-3 weeks by transplanting instead of direct seeding. Transplanting also permits more even stands, better weed control, and reduced harvesting costs. Lettuce fertilization studies indicate 100-125 pounds per acre nitrogen (N) applied as ammonium nitrate is sufficient to maximize yields in 'Salinas' head lettuce. Higher rates of application neither increase yields nor enhance harvest date.

A comparison of the performance of lettuce transplants of different ages indicated the 17-day-old plant was too young for best results. The small size of the root and shoot made transplanting difficult without injury, and the resulting transplant shock was manifested by irregular rates of development and times of harvest. Transplants 24 or 31 days old performed well and were not different from one another with respect to percent harvest, head weight, and harvest date. The industry standard has been 31 days, but this study suggests a younger transplant can perform just as well in the field. This knowledge may contribute to a reduction in transplant production costs. *D. E. Carling.*

Effects of Different Polyethylene Mulches and Row Covers on Yield of Day-Neutral Strawberries

Strawberries have been produced commercially and by home gardeners in the Interior since the late 1970s using clear polyethylene mulch and row covers to promote early fruiting of day-neutral strawberries. The major drawback of this technique is that it requires the use of herbicides or inefficient hand weeding. Black or other opaque mulches have been used with limited success as a means of weed control. The objective of this three-year study is to determine the effect of various mulches on strawberry yield, soil temperatures, and air temperatures above the mulch. After one growing season, yields using clear polyethylene mulch with or without row covers (189.4 pounds and 171.3 pounds per 100-foot row, respectively) were significantly greater than with all other mulch treatments. Yields for other mulch treatments ranged from 102.9 to 128.9 pounds per 100 foot for black polyethylene; black over white two-sided, embossed polyethylene; black latex spray; permeable mulch; or white over black two-sided, embossed polyethylene. All of these treatments included clear polyethylene row covers. Unmulched strawberries (control) and those grown on a black polyethylene mulch, each without row covers, yielded 53.2 pounds and 52.3 pounds per 100 foot., respectively. *G. Matheke, P. Wagner, P. Holloway.*

Effects of Stone and Wood-Chip Mulches on Growth of Several Woody Ornamentals

Six woody ornamental trees and shrubs (*Rosa rugosa, Cotoneaster acutifolia, Malus baccata, Picea glauca, Pinus contorta, Pinus mugo mugus*) have been grown on bottomland Tanana silt loam soil since 1983 under five mulch treatments: 1 or 2 inches of Brown's Hill Quarry stone, 2 or 4 inches of quaking aspen wood chips, and a control. Annual shoot and leaf growth was monitored along with environmental information on soil moisture, soil and air temperature, and weed growth on each mulch treatment. The project will be completed in 1988, but preliminary results show that the wood chip mulch provides the best weed control but significantly reduces soil temperatures. Certain ornamentals, especially *Rosa rugosa*, show significant reductions in growth on the wood chip mulch, but growth reductions were not observed on all species. The black stone mulch provides some weed control, especially the 2-inch layer, and the stones warm the soil, providing an excellent growing environment for all the ornamentals. This project was initiated in response to local grower inquiries regarding the use of chip or bark mulches in ornamental landscapes. These organic mulches are routinely specified in public landscape contracts, but their effects on plant growth over time were not known. *P. Holloway.*

Variety 'Kenai' Polargrass Released for Commercial Production

The variety 'Kenai' polargrass (*Arctagrostis latifolia*) was released for use as a forage grass and for conservation purposes in the southcentral to western and southern interior portions of Alaska. Breeder seed was submitted to the Plant Materials Center in Palmer in 1987 for increase at the foundation seed level. This class of seed should be available from the PMC to commercial growers for production of certified seed after the harvest of the 1988 seed crop.

Polargrass is a circumboreal species that is restricted in its distribution to northern boreal and Arctic latitudes. It occurs throughout most of mainland Alaska, inhabiting bogs, alpine and Arctic tundras, and various meadows and fringes of wooded areas. It is not well adapted to dry sites. Under good growing conditions, it produces a tall, leafy plant with relatively broad leaves, and it can spread by means of short, stout underground stems (rhizomes) that grow laterally. The breeding components for the variety Kenai are based on collections made at the townsite of Kenai and between Soldotna and Homer on the Kenai Peninsula.

These components have performed well in forage trials on strongly acidic soils through the southcentral region. Although two harvests were generally taken during the growing season, these trials were in areas where it often is the custom of farmers to take but a single harvest. In comparisons with a number of other grasses, components of Kenai polargrass averaged the highest first-harvest yield over a five-year period at a subalpine site on the lower Kenai Peninsula, provided the second highest yield below 'Engmo' timothy over a four-year period in a trial on the upper Kenai Peninsula, and were the top producers over 2 years in a trial near Talkeetna in the upper Susitna Valley. The components also performed well in a trial near Delta.

Components of Kenai were tested in revegetation trials on coal spoil materials at surface-mine sites. These were among the best performers in trials at test pits in the Beluga coal field in the upper Cook Inlet region west of Anchorage. They also performed reasonably well in some tests at the Usibelli coal mine south of Fairbanks.

Kenai polargrass has shown a greater tolerance of icing conditions than has timothy in some trials seriously affected by ice accumulations.

Such conditions have caused serious winterkill in forage fields in southcentral Alaska. The Kenai components also appear immune to the effects of snow mold that can inflict serious damage on a number of grasses, including timothy.

Kenai best merits consideration as a forage grass at cool-season locations with strongly acidic soils. It has persisted well in sites of this nature, but it can be subject to injury when harvested under droughty conditions. It would probably fit the one-harvest-per-season management system better than the two-harvests-per-season system. Kenai will provide an additional choice for an indigenous revegetation grass, thus helping to satisfy permitting requirements for the establishment of a diverse flora including indigenous materials. Kenai may also provide an option for the moist, boggy soils that are difficult to revegetate. *Wm. W. Mitchell.*

Response of Oat Forage to Nitrogen and Phosphorus Fertilization

Two trials involving nitrogen (N) and phosphorus (P) fertilization of oat forage (variety 'Toral') were continued in 1987 from the previous year at Pt. MacKenzie. In one trial, five rates of P_2O_5 were applied ranging from 0 to 120 pounds per acre with N and potassium (K) kept constant. In addition, five rates of N were applied, as above, with P and K kept constant. The oats were harvested in the fully headed stage. In the second trial, three rates of N were applied at two rates of P with harvests taken at three different stages of growth (head emergence, fully headed, and milk stage).

Yield responses to N in both trials indicated little or no increase in yields resulting from N applications above 70 pounds per acre. Applying phosphorus at 80 to 90 pounds P_2O_5 per acre increased yields above those obtained with 40 to 60 pounds P_2O_5 per acre. In the trial with harvests taken at three different growth stages, yield responses to increasing N and P rates were similar at all three stages. Yields of about 2 tons per acre were obtained at head-emergence stage, about 3 tons per acre at fully headed stage, and about 4 tons per acre at milk stage with 70 pounds N applied.

Although N applications above 60 to 70 pounds per acre failed to increase yields, the higher N treatments produced substantial increases in crude protein concentrations. When the crop was harvested at the late headed stage, crude protein contents of oat herbage ranged from 6.5 percent with no N applied to 11.5 percent with applications of 120 pounds N per acre . In the three-harvest-stage trial, crude-protein content of oat herbage fertilized at 35 pounds N per acre declined from 9.9 percent when cut in the head-emergence stage to 5.4 percent when cut in the milk stage; with 105 pounds per acre applied, it declined from 17.4 percent to 8.9 percent over the same stages of growth. The research further indicated that increasing yields (by increasing P treatments) without supplying adequate N can produce a reduction of crude protein content. An increase in yield must be accompanied by a compensating increase in N uptake to prevent dilution of crude-protein content.

Moisture conditions were good during the 1987 growing season. The results of these and other trials indicate that, under moderate to good growing conditions at Pt. MacKenzie, oats fertilized with 70 to 90 pounds N per acre and 40 to 60 pounds P_2O_5 per acre can provide 2 to more than 2.5 tons of dry matter per acre containing about 10 to 12 percent crude protein when cut in the headed stage. Yields can be increased with higher rates of P, and crude protein can be increased with higher rates of N.

Although K appears not to be limiting on newly cleared ground at Pt. MacKenzie, it is subject to depletion, so application of K is advisable, at least after two to three years of cropping. *Wm. W. Mitchell.*

Effects of Delayed Harvest of Timothy

Forage operators are generally advised to harvest a perennial grass crop in the boot to head-emergence stage, at which stage it can generally be expected to provide an acceptable yield along with good quality. Operators sometimes delay harvests beyond this stage for various reasons, however, resulting in a loss in quality of the harvested forage. The decision is sometimes made to take a single harvest during a growing season, rather than the often-taken two harvests, and to delay that harvest beyond the usual time for taking a first harvest in order to augment the yield. The effect of such a decision was tested in neighboring trials conducted on Flathorn silt loam at Pt. MacKenzie in which a number of perennial grasses were managed for two harvests in one trial and for a single harvest in the other trial. Both trials were fertilized with 20-20-15 at 500 pounds per acre at the start of the growing season.

The first harvest of the two-harvest trial was taken on June 16 when 'Engmo' timothy was in the boot stage. The single harvest in the other trial was taken on July 16 after Engmo timothy was fully headed. Comparisons of yields and four components of forage quality indicate the effects of the different harvest stages on Engmo timothy. Delaying harvest for 1 month about doubled the yield, from 1.59 tons of oven-dry matter per acre for the June 16 harvest to 3.02 tons per acre for the July 16 harvest. The two yield figures would be 1.81 and 3.43 tons per acre, respectively, on a hay-weight basis. Crude protein (C.P.) content was reduced almost 50 percent from 17.4 percent C.P. in the early harvest to 9.3 percent in the late harvest. Phosphorus (P) content declined from 0.42 percent to 0.19 percent. Calcium (Ca) content increased, however, from 0.26 percent to 0.31 percent. Digestibility decreased from a high value of 71.8 percent to a moderately good value of 63.4 percent. Thus the decline in digestibility was at a much lower rate than it was for crude protein. The decrease in phosphorus (P) content and concomitant increase in Ca content resulted in a more favorable Ca:P ratio, over 1:1 in the late-harvest herbage, than the less than 1:1 ratio in the early-harvest herbage. The P content of the late-harvest material was low, however, for high-producing animals.

The decision to delay harvest in order to augment yield must take into consideration the purpose of the forage. If it is intended for dairy animals to promote high milk production, then the higher-quality forage is desired. If it is intended for animals that are to be put on a maintenance, nongaining ration, then the later-harvest material would suffice, although it is borderline in C.P. content. The early-harvest timothy provided excellent quality perennial grass forage with over 17 percent crude protein and over 70 percent digestible dry matter. *Wm. W. Mitchell.*

Anhydrous Ammonia as a Fertilizer for Alaska

Anhydrous ammonia is a very high analysis nitrogen (N) fertilizer which is usually cheaper on a per-unit-of-N basis than are other N fertilizers. Anhydrous ammonia is manufactured in Alaska at Kenai, but at present all of it is shipped out of state and is not available in state. Because anhydrous ammonia is potentially a cheaper source of N than other N fertilizers, Alaskan farmers are interested in using it as a fertilizer for production of small grains. Should demand for anhydrous ammonia become high enough in Alaska, it would be made available to Alaska farmers. However, information is first needed on the effectiveness of anhydrous ammonia as a fertilizer in Alaska.

The primary objective of this study was to determine whether the use of anhydrous ammonia as an N fertilizer for small grains is feasible in interior Alaska. The secondary objectives were: 1) to compare barley responses to anhydrous ammonia with that of urea and ammonium nitrate, all applied at the same rate of N; 2) to compare barley responses to fall-applied anhydrous ammonia with that of spring-applied anhydrous ammonia; and 3) to determine nitrification patterns of anhydrous ammonia in an acid and in a neutral soil in interior Alaska.

Two sites in interior Alaska, one on an acid soil near Delta Junction and one on a neutral soil at Fairbanks, were selected for this 3-year study completed in 1987. Anhydrous ammonia was applied at a rate of 90 pounds N per acre in the fall and in the spring, and urea and ammonium nitrate were applied in the spring, also at 90 pounds N per acre. Barley was used as the test crop. Soil samples were collected throughout the growing season from the plot, and plant samples were collected at physiological maturity. The soil samples were analyzed for ammonium and nitrate to determine the rate of nitrification (conversion of ammonium to nitrate). The plant samples were analyzed for total N in order to determine plant N uptake from the different fertilizers. Also, at the end of the growing season, grain yield and grain N content were measured.

Statistical analyses of the data are not yet complete, but there appears to have been no differences in crop yield or plant N uptake due to kind of fertilizer or time of application. Nitrification of ammonium for each of the fertilizers proceeded rapidly at both sites. By mid- to late June (about 1 1/2 months after planting), most of the fertilizer N had apparently either been taken up by plants or incorporated into soil organic matter. Results of this study indicate that anhydrous ammonia is a good source of N for small grains in interior Alaska. *S. D. Sparrow.*

Phosphorus Soil Test Calibration

Agricultural activity in Alaska takes place on a wide range of soil environments. The phosphorus (P) soil test is known to perform very differently depending on both extractant and soil properties. With a wide variety of soils under cultivation in Alaska, a study was conducted to identify a soil P extractant suitable for use on all soils. The Mehlich 3 multi-element extractant was identified as suitable for representative agricultural soils in Alaska. The purpose of this study is to identify the relationship between Mehlich 3 P and crop yield for representative soils and determine critical Mehlich 3 P levels.

The field calibrations study was initiated in the spring of 1984. Fertilizer P (TSP, 0-45-0) was applied to plots at nine locations representing major agricultural areas in Alaska. The rates of P application were calculated from the laboratory P-sorption isotherms. Plots were established at each site in a randomized complete block design containing four

blocks. Fertilizer was rototilled into the top 6 inches of soil and was allowed to equilibrate in 1984. The first crop was planted in the spring of 1985. Uniform nitrogen (N), potassium (K) fertilizers (120 pounds per acre as urea, 62 pounds K per acre as potassium sulfate) were applied. Four sites were planted to 'Toral' oats, and five sites were planted to 'Weal' barley. All plots were harvested in the fall to determine forage yield. Soil samples were taken from each plot in the spring and fall for soil testing.

After 3 years of cropping, the Mehlich 3 P soil tests are found to be well related to P-application rate for all soils tested. The field P-application rates to establish desired Mehlich 3 P levels can be accurately estimated from the field data which provide a good estimate of the critical soil-test levels for all soils. The critical Mehlich 3 P levels in turn provide the basis for soil P test and fertilizer recommendations for all soils. The Mehlich 3 P levels for volcanic ash soils in the Susitna Valley and Kenai Peninsula are found to be 13 and 17 parts per million, and the P-application rates to establish this critical level to be 500 and 560 pound per acre, respectively. The Mehlich 3 P levels for loess soils in the Delta Junction, Copper River basin, and Matanuska Valley areas range from 13 to 57 parts per million, and the P-application rates range from 60 to 136 pounds per acre. *C.-L. Ping and G. J. Michaelson.*

Effects of Application Rates and Disposal Techniques of Dairy Manure on Oat Forages

The effect of disposing of and using dairy manures as a fertilizer on oat silage grown in a cold environment were analyzed. Application rates sufficient to supply nitrogen (N) at three rates (40, 100, 160 pounds per acre) under three techniques (broadcast, incorporate, and inject) were evaluated for both dairy manure and urea.

The third-year results of oat yields showed significant differences among the urea and manure plots, with the highest rates producing the highest yields. There were no significant differences between the two sources; however, the urea plots possessed uniform growth whereas the manure broadcast had spotty growth. The general trend among the techniques when ranked by highest yield was incorporation, broadcast, and injection. One should not inject on these shallow soils because little lateral movement of nitrate occurred, as indicated by bands of dark green forage between yellow forage strips. The protein analyses showed a higher content from the manure plots compared to the urea plots. The soil samples did not indicate increases in nitrates in the 6- to 12-inch region, thus the waste material at the high rates of 160 pounds per acre is being assimilated by the soil-crop regime. *R. F. Cullum, G. A. Michaelson, and C.-L. Ping.*

Characteristics and Feed Value of Barley and Western Protein Supplements for Swine

Barley is the major cereal grain for production in Alaska. Five spring barley cultivars ('Datal', 'Lidal', 'Otal', 'Weal', and 'Thual') have been developed and released for commercial production in Alaska by Roscoe Taylor (ARS, Palmer, Alaska). The first three are early-maturing, six-row, covered barleys. Weal barley was developed as a six-row hooded (awnless) cultivar for forage production. Thual is a six-row naked-kernel (hulless) cultivar and is only one of three currently under commercial production in North America. The other two hulless cultivars are 'Scout' and 'Tupper' from Saskatchewan, Canada. Although agronomic characteristics have been reported for these five barleys, nutrient content of

these cultivars has not been extensively studied. All cultivars should be considered feed grains, and there have been reports in the literature that the lower crude-fiber content of hulless barleys may not be associated with improved feeding value for chicks, rats, and pigs.

All five cultivars were collected or produced at two locations (Delta Junction or Fairbanks) for three seasons and analyzed for nutrient content. In addition, samples were analyzed for beta-glucan and acid and alkali viscosity at Washington State University (Dr. S. Ullrich). These latter components have been related to a decrease in the feeding value of barley, specifically hulless barley.

With the exception of Weal (12.8 percent crude protein (C.P.)), C.P. contents of the other cultivars were not different by cultivar, season, or location (15.5 percent C.P.) on a dry-matter basis. Essential amino acid content was not different, and lysine, the first limiting amino acid for swine diets, was 0.40 percent. In both locations, Thual contained less acid detergent fiber and greater available energy estimated from in vitro dry matter disappearance (IVDMD) with 4.5 and 86.4 percent D.M. basis, respectively, than the covered cultivars with 6.9 and 81.1 percent, respectively. Weal barley had slightly greater fiber and lower IVDMD (7.4 and 79.4 percent, respectively). A location effect was noted between hulless and covered barleys for beta-glucan content. Thual produced in Fairbanks had the greatest beta-glucan content (4.9 percent) followed by Thual from Delta Junction with 3.4 percent and covered barleys at Fairbanks containing 4.9 percent beta-glucan. Although both acid and alkaline viscosity results were poorly correlated with the beta-glucan content, covered barleys produced in Fairbanks were higher in both parameters followed by hulless varieties from both Fairbanks and Delta Junction. Barleys from Delta Junction have been reported to be routinely lower in test weight than similar cultivars grown at Fairbanks. If the test weight was lower in the Delta Junction samples, there may have been a decreased starch content in the kernel and, therefore, a reduction in the beta-glucan content associated with the starch fraction. *F. M. Husby.*

W-166, All-Barley Starter Pig Diets Containing High- and Low-Salt Herring Meal

Herring meal produced in Alaska represents one of the highest-quality protein supplements available in the feedstuff market today. Although it sells for a higher price, the quality of the protein would appear to be well suited for diets with those species and age of animals and livestock that require high-quality and available amino acids. Diet quality is important for the early-weaned pig to assist in the prevention of the post-weaning check. A study was conducted to determine the effect of replacing soybean meal with herring meal with two salt levels in all-barley starter pig diets.

Four diets were formulated to include a standard corn-soybean starter diet, a 100 percent barley replacement of corn, and two herring meal diets to contain 10 percent high- (6.0 percent) or low-salt (1.9 percent) herring meal from salt-packed or frozen-packed herring carcasses, respectively. All diets were formulated to meet N.R.C. requirements for the 22-pound pig with vitamins and minerals to be included at 125 percent of N.R.C. recommendations. Each diet contained 20 percent dried whey, and the fat content was equalized at 3 percent with the addition of corn oil. Twenty-four pigs were allotted to two replications of four diets to be fed from 35 to 63 days of age (25.3 to 66.7 pound body weight). Pigs fed the corn-based starter diet had significantly greater average daily gains than the three all-barley or barley-herring meal diets.

Pounds per day gain were 1.54, 1.40, 1.36, and 1.34 for the corn, all-barley, barley+high-salt herring meal, and barley+low-salt herring meal, respectively. The feed efficiency was similar for the three all-barley and herring meal diets (1.96, 1.94, 1.99 pound feed per pound gain, respectively), and the corn based diet was only slightly better with a feed efficiency of 1.87 pound feed per pound gain.

The utilization of barley and herring meal, regardless of salt level, provided satisfactory rate and efficiency of gains and should be utilized when cost effective over imported corn and soybean meal. Historically, the literature has reported that barley should not be included in starter pig diets, and that, if included, dietary levels should not exceed 25 percent. In our three diets, barley content ranged from 52 to 61 percent. *F. M. Husby.*

Protein Quality of Alaskan Herring Meal with High and Low Salt Content

Since 1985, a cooperative research study has been conducted with AFES and a Fairbanks feed mill, Kobuk Fuel and Feed, to develop a locally produced high-performance (30 percent crude protein (C.P.), 20 percent E.E.) sled dog diet containing Alaskan barley ('Thual', a hulless cultivar) and herring meal as the main protein supplement. The final product contained enough herring meal to provide greater than 50 percent of the total dietary protein. The dry-matter and C.P. digestibilities were 76 and 83 percent, respectively, comparable to similar diets imported from the "Lower 48." Herring meal is produced from whole carcasses either frozen or packed in 20 percent salt shortly after capture to preserve and age the fish for later removal of the roe. The process involves grinding the carcasses, and cooking for 15-20 minutes at 80 and 90 degrees Celsius for salt-packed herring and frozen-packed herring, respectively. The product is then pressed to remove the liquid phase and this is separated by centrifugation into oil and an aqueous phase that is concentrated to stick water. Stick water from frozen-packed herring is added back to the press cake prior to drying. Stick water from the salt-packed herring is discarded as the salt content of the stick water would raise the salt content to above 20 percent in the meal. Salt content of salt-packed herring meal ranged from 4-6 percent, while frozen-packed meals contained 0.4-3 percent salt.

In the formulation of dog diets with high-salt herring meals, the salt content reached 1.7 percent of the total diet. A major concern of dog mushers is the potential for dehydration during competition and whether the salt content would affect the value of the dietary protein. Therefore, a rat study was conducted to compare high- and low- salt herring meals to salmon, halibut, and soybean oil meals (in cooperation with members of W-166, Western Regional Swine Nutrition Project).

The salt-packed herring meal contained the greatest percent lysine on a dry basis (6.02 percent) and as a percentage of protein (8.67 percent) as well as the greatest total percentage of essential amino acids. The performance of the rats, as judged by total gain, feed efficiency, protein efficiency ratio, biological value, net protein utilization, and dry fat-free body mass, was the best for salt-packed herring meal. In conclusion, the higher lysine of protein in salt-packed herring meal resulted in the superior performance of the rats fed the diets, and the high sodium level did not adversely affect the growth performance, biological value, and net protein utilization of the protein. Following the racing season, no reports of dehydration were received from mushers who had fed the dog food containing a higher-salt herring meal throughout the racing season. *F. M. Husby.*

Hulless Barley and Tanner Crab Shell in Beef Cattle Finishing Rations

Previous research with crab meal at this station demonstrated that, following physical separation, the fine material passing through a 40-mesh sieve had an improved nutritional quality. This improved quality was determined by an increase in both crude protein (C.P.) and essential amino acid content. Although crab meal was limited to a 50 percent replacement of soybean meal in growing-finishing swine diets, the fine material successfully replaced 100 percent of soybean meal in similar barley-based diets. The coarse material or crab shell (>40-mesh) contained a greater level of chitin (determined by acid detergent fiber) and ash and may be utilized as a fiber source in cattle rations. Following a 6-week adaptation to a crab meal diet, both in vitro Tilley and Terry and in vitro nylon-bag digestibility of chitin was significantly increased in beef cattle. Results from total digestibility trials with beef cattle also indicate that some of the chitin (measured as acid detergent fiber) was utilized when crab meal replaced 15 percent of brome grass hay in maintenance diets.

In this study, coarse tanner crab shell was compared to brome grass hay as a roughage source in beef cattle finishing rations containing a new commercially produced hulless barley cultivar, 'Thual', that was developed in Alaska by Roscoe Taylor (ARS, Palmer, AK). The diets were Thual barley : brome hay or crab shell (85:15) and balanced for minerals. Steers received injectable vitamins A, D, and E. Three Hereford steers each were randomly allotted to the two diet treatments, and the steers were individually fed and penned. Steers were fed for 126 days from 920 to 1300 pound body weight. Both the rate and efficiency of gains were significantly better for steers fed the diet containing brome grass vs. crab shell (3.3 vs. 2.2 pound per day of gain and 6.05 vs. 7.2 pound of feed per pound of gain, respectively). Rumen pH was 6.1 and 5.3 for brome grass and crab shell diets, respectively.

The hulless barley, Thual, was an acceptable grain for beef cattle finishing rations. However, crab shell may not provide sufficient energy for optimum body weight gains. In addition, the lower pH of rumen fluid from steers fed the crab shell diet would indicate that crab shell may not provide the buffering capacity of roughage and therefore may not be adequate roughage replacement in high-concentrate finishing diets. *F. M. Husby.*

Plant and Marine Complementarity in Dairy Cattle Rations

Dairy cattle require high levels of protein and energy in their feed to maintain milk production. Alaska's roughage sources are low in crude protein, at 7 to 10 percent, compared to roughages such as alfalfa at 17 percent crude protein. The concentrate portion of the Alaska dairy cow's diet, therefore, must be high in protein as well as energy.

Alaska salmon meal, with 60 percent crude protein (C.P.), is considerably higher in protein than soybean meal, with 48 percent C.P. The relatively high level of oil in salmon meal, compared to plant meals, also adds energy to the ration. There has been concern, however, that this oil will cause reduction in the fat content of milk produced from cows fed concentrates containing salmon meal.

An intensive study of twenty-five Holstein cows was conducted in 1987. Five cows were fed one of the five experimental rations for a period of 2 weeks prepartum and 15 weeks postpartum. Experimental concentrates replaced 0, 25, 50, 75, or 100 percent of the soybean meal protein source with salmon meal. Biweekly fecal, blood, and ruminal fluid

samples were collected from these animals. Milk production, feed intake and cow weight were closely monitored during the experimental period. This study was completed in May 1987; lab analyses and data analysis are continuing in 1988. *L. B. Bruce.*

Feedstuffs for Beef Production in Alaska

Alaska produces a variety of nontraditional crops that have significant potential as livestock feeds if they can be used correctly in a balanced diet. To study this, two trials were initiated in December 1987; one with finishing beef steers and another with replacement beef heifers. Twenty-four steers were divided into three groups and placed on finishing rations using Alaska-grown whole canola seed as a protein source and either corn, Alaska barley, or a corn/Alaska barley mix as the energy feed. Twelve replacement heifers were divided into two groups and fed Alaska barley and Alaska brome hay as their energy source with either Alaska fishmeal or Alaska peas as their protein source.

These animals are weighed every two weeks, with careful feed intake records maintained daily. When the steers are slaughtered, carcass data will be gathered. Reproductive performance of the replacement heifers will be followed. A better understanding of Alaska crops as beef cattle feeds should be gained from these studies, permitting us to make ration recommendations to producers using local feeds. *L. B. Bruce.*

Dietary Selenium in Supplementation for Beef Cattle

Feedstuffs grown in Alaska are typically deficient in selenium. A study with thirty-two crossbred Alaskan beef cows is being conducted to compare methods of selenium supplementation. This is the second year of the study. In year one, control cattle had blood-selenium levels of 20 parts per billion (ppb). Monthly injections of selenium raised blood levels to 70 ppb, and soybean supplementation raised blood levels to 50 ppb. The desired blood-selenium level for beef cattle is 100 ppb. In the summer of 1987, these cattle were pastured on grasses with low selenium content. At the beginning of the winter season, the cattle were gathered and blood samples taken. The cattle were then split into four groups: no selenium supplementation, selenium supplemented by ingestion of soybean meal, selenium supplemented with monthly intramuscular injections, and selenium supplemented by a single injection 6 weeks prior to calving.

These cows are weighed and blood and ruminal fluid samples are taken monthly. Dietary intake is closely monitored. The feeding and injections began in mid-December and will continue until April. At calving, observations are made on the status of both the cow and her calf. Analyses of blood and ruminal fluid, as well as cow-calf performance will be used to evaluate the success of the various supplementation treatments. Results of these studies on selenium should help Alaskan producers improve the reproductive performance of their cows and increase their calf crop. *L. B. Bruce.*

Alternate Approaches to Calculation of Beef Cattle Dietary Intake

Use of net energy values to balance beef cattle diets for specific intakes and average daily gains is difficult because feeds are utilized differently for maintenance and gain. In this study, coefficients were derived for use in the quadratic formula which precisely calculated percentages of two feeds needed to meet required NEg and NEm. Once this algorithm was established, the intake prediction equation used by NRC was evaluated. This equation was incorporated into the balancing equation and reduced. This reduction yielded a quartic equation that is solved by the trigonometric method. Use of the quartic equation allows the calculation of rations without an extra step for calculating intake. To incorporate this technique into simplified calculations for field balancing of rations, the quartic equation was resolved using a variation of Newton's method for solving equations. This was done for several classes of beef cattle, yielding simplified equations for use with a hand-held calculator for predicting intake. Evaluations are continuing in order to develop equations for use in calculating least-cost feeding programs. *L. B. Bruce.*

The Effect of Crude Fiber on the Digestibility of High Protein-High Fat Complete Sled Dog Diets

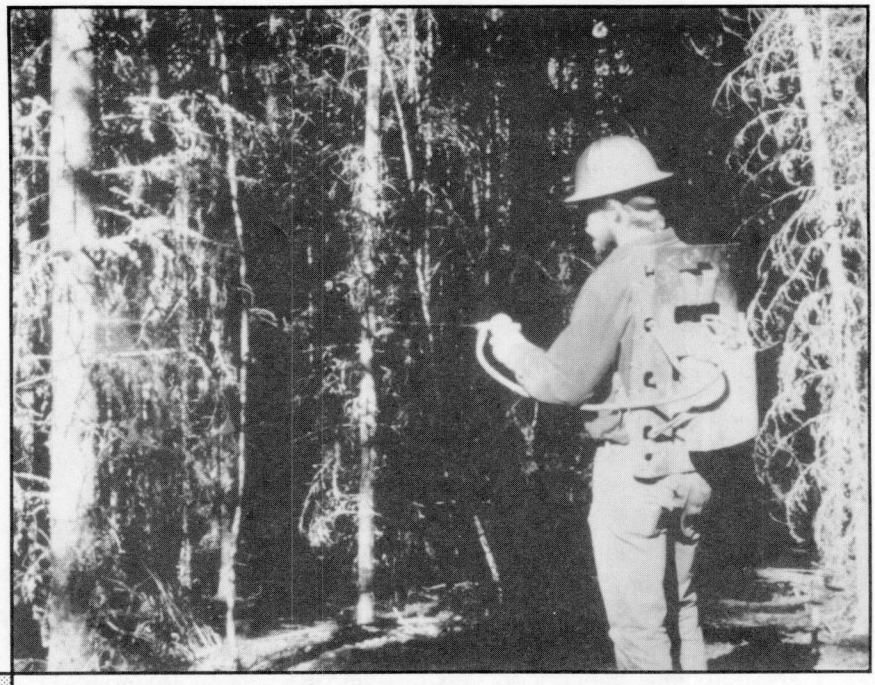
The nutrition and feeding of sled dogs should be considered a combination of art and science. Little definitive information concerning the nutrient requirements of dogs, let alone sled dogs, is available to formulate diets for feeding programs with any degree of certainty. However, over the last 15 years some significant changes have occurred in sled dog feeding programs. Historically, mushers have prepared and cooked their own dog food mixed from a wide selection of ingredients. These ingredients included a cereal grain (usually polished rice), meat and/or animal by-products, dried fish, fat from several sources, vitamins, and minerals. Recently, dog food manufacturers have attempted to remove the guesswork inherent in attempting to mix a balanced feed in a cook pot from raw ingredients. Over the last 10 years, high-performance dry feeds have been formulated to contain 30 percent crude protein (C.P.) and 20 percent fat from high-quality feed ingredients to maximize the digestibility and nutrient availability. Most of the 30:20-type diets have not been considered complete diets by the mushers, and they routinely attempt to improve nutrient density, digestibility, and palatability of these diets by supplementing with 15-60 percent (by weight) meat (chicken, turkey, lamb, horse, moose, beaver), fat, and vitamins and minerals. For the long-distance racer, the use of meat supplements adds extra weight as water that must be carried in the sled or shipped to check points on the race trail.

Within the last year, several protein- and energy-dense diets have been tested in the field by mushers. These diets are intended to be a complete dry diet with 30-38 percent protein and 25-40 percent fat. With the increased quality of ingredients and digestibility, the musher could significantly reduce the amount of food to be utilized during a race. A complete diet containing 35 percent C.P. and 25 percent fat was developed in cooperation with Professor R. Wolter (National Veterinary School, Alfort, France). The carbohydrate portion was provided from equal amounts of corn and rice, protein from both plant and animal products with enough herring meal to provide approximately 50 percent of the total protein, a blend of fats from several sources, and supplemental minerals (especially divalent cations and B vitamins) at 2-3 times the N.R.C. recommended levels. A fat supplement was blended from the same fat sources in the same ratio as provided in the dry diet. To enhance the available energy, no fiber was included in the diet. However, during field

testing, some soft stools were routinely excreted by the dogs. A digestibility trial with six sled dogs was conducted to determine the effect of supplemental crude fiber levels on dry matter and nutrient digestibilities. Fiber (from beet pulp) levels were 1, 2, and 3 percent of dry matter content.

As crude fiber content increased from 1 to 3 percent in low, medium, and high crude fiber diets, the dry matter (D.M.) digestibility was reduced approximately 2 percent with a 1 percent increase in fiber. (D.M. digestibilities for low, medium, and high levels of fiber were 80.0, 77.4, and 75.8 percent, respectively). The reduction in D.M. digestibility appeared to be the result of a reduction in the nitrogen-free extract (starch) portion in low, medium, and high fiber diets of 84.8, 78.6, and 77.5 percent respectively. C.P. and fat digestibilities were not affected by dietary crude fiber level. The supplementation of the low-fiber diet with lecithin (2.4 grams per dog per day) did not improve D.M. or fat digestibility. The decreased D.M. and starch digestibilities without a change for protein or fat are typical of the type of fiber in beet pulp. In addition, percent fecal water significantly increased with an increase in fiber from 1 to 2 to 3 percent from 51.6, 61.8, to 67.9 percent, respectively. Following several months of field testing, the removal of supplemental limestone from the low-fiber diet significantly improved stool quality.

The complete diet concept was effective in maintaining dog body weight with 240 grams (8.5 ounces) of dry dog food per day compared to 340 grams (12 ounces) of the 30-20 type dog foods. The lower fiber level was associated with improved diet digestibility and a reduction in water loss via the fecal material. *F. M. Husby.*



Graduate students at the School of Agriculture and Land Resources Management have many opportunities to pursue research which includes field work as studies continue on the many factors which influence the establishment, growth, and productivity of Alaska's Boreal forests.

Forest Sciences

Controls of Nitrogen Cycling in Successional Forests In Interior Alaska

Estimates of denitrification and nitrogen (N) fixation were made in the forest floor and mineral soil in a 5-year-old willow/poplar stand, a 27-year-old alder stand, and in a mature white spruce stand (165 years old). These vegetation types represent early and late successional stages on the Tanana River of interior Alaska. Highest potential and *in situ* denitrification rates, 27 and $2x10^{-9}$ pounds N_2O $acre^{-1}d^{-1}$, respectively, were observed in the alder forest floor. Low to undetectable rates were measured in the other stands. Laboratory experiments indicate anaerobiosis as a possible major limiting factor for denitrification. Alder root nodules showed the greatest nitrogenase activity, $560x10^{-9}$ moles C_2H_4 $acre^{-1}d^{-1}$; while lower rates were measured within the flooded willow/poplar soil, $13x10^{-9}$ moles C_2H_4 $acre^{-1}d^{-1}$; and within the white spruce moss layer, $9x10^{-9}$ moles C_2H_4 $acre^{-1}d^{-1}$. Observed estimates of N fixation and denitrification indicate mean daily inputs of N as 5.8 and 0.08 pounds N $acre^{-1}d^{-1}$, respectively, which quantitatively substantiates the importance of N-fixing alder in the build-up of N and organic matter reserves in primary successional soils of interior Alaska.

Successional patterns have been examined for some important soil physical and chemical controls of element supply for plant use. In primary successional floodplain soils, the available moisture range (moisture content of soil determined between .2 and 15 bars moisture suction) for soils between time zero and 200 years in the forest-development hierarchy is strongly related to the sand content of the soil profiles. Sixty-two percent of the variation in the estimates of available moisture range was explained by soil profile sand content. Indices of soil organic matter content play a secondary role in this regard. At the extremes of this moisture range, the 15-bar moisture content for these soils is most strongly related to soil organic matter content (R^2=.95) while the .2 bar moisture content is closely related to the amount of sand present in the soil (R^2=.64). Soil organic matter content explained 12 percent of the variation in the .2 bar moisture percent. The available moisture range

appears to largely reflect physical conditions that control low soil moisture suction, especially soil sand content. The cation exchange capacity of this successional sequence of soils is strongly related to soil organic matter content. With the exception of the time zero soils where sand plays the dominant role in particle size distribution, silt size fractions are the dominant particle size with clay rarely comprising 10 percent of the mineral fractions. Because of the young character of the floodplain soils and restricted rate of primary mineral weathering in the cold-dominated environment, organic matter plays an important role in cation retention in these entisols.

Successional patterns in soil chemical properties reflect the change from primarily physical-chemical control of soil nutrient status in early stages of forest development, to biological control as plant communities become established. These changes occur in the first 5-10 years of plant community development on the floodplain. The N and organic carbon content of the surface soil increases from less than .01 percent and .04 percent at time zero to .04 percent and .4 percent, respectively, at 5 years following plant establishment. During the alder stage (10-30 years) surface soil N concentration may nearly triple to .14 percent. By the time white spruce forests have matured, the surface soil N content has increased to near .2 percent and the organic carbon content is greater than 3 percent. During this time interval, soil pH has declined from alkaline (7.2-7.3) to slightly to moderately acidic (5.7-6.1), carbonate content has declined from 1.4 percent to .4 percent, extractable phosphorus has increased from 1 part per million (ppm) to in excess of 3 ppm, and cation exchange capacity has increased from 2- to 20 me/100g. These conditions reflect the increased influence of plant control of the soil environment, and element recycling on soil chemistry, following the initial colonization phase. Research currently is underway to evaluate some of the hypothesized controls for element dynamics in these floodplain soils. *K. Klingensmith and K. VanCleve.*

Silvics

Selection of the tree species best suited to the site is the most important decision a forest manager can make. Research during 1987 continued to emphasize tamarack. Tamarack and other species of larch are attracting increasing attention. In the Great Lakes states they are a preferred species on many sites; excellent stands are being intensively managed in northern Minnesota. Both bare-root and container nurseries produce good-quality seedlings. In one 2-year-old plantation of tamarack near Fairbanks, many seedlings had better leader growth than adjacent white spruce seedlings planted at the same time.

During 1987, emphasis on northern forest hardwoods, especially aspen and paper birch, was increased. The aspen resource of Minnesota, which less than a decade ago was considered nearly inexhaustible, is now almost completely committed and shortages loom on the horizon. Aspen is easy to regenerate; it sprouts from roots and stumps. The two species of birch found in Scandinavia appear to be going through a demand cycle similar to aspen in Minnesota. Today, 12 percent of the pulp in portions of Scandinavia is birch, and good veneer birch is becoming scarce. Alaska has extensive areas of land supporting paper birch; many of these stands are understocked and overmature. The Alaska paper birch resource is attracting considerable attention.

During 1987, the Alaskan Forest Tree Improvement Cooperative was established. Tree improvement, the selection of the highest-quality

genetic stock and maintenance of the gene pool, is an important aspect of any reforestation program. The Agricultural and Forestry Experiment Station has been involved in the cooperative from the outset. Also during the summer of 1987, station personnel assisted the Nordic Tree Improvement Cooperative (Denmark, Finland, Greenland, Norway, and Sweden) collect cones in northwestern Canada and Alaska. Collections in Canada were lodgepole pine; those in Alaska were black and white spruce and tamarack. The Nordic countries have a massive reforestation program that ensures high productivity of their forest lands, and they utilize North American species as well as those native to Europe.

A search of the literature for fungal associates of tamarack continues. The pathogen of major concern is that which causes larch canker. It is having a devastating effect in the Maritime Provinces of Canada where, in some localities, nearly all tamarack trees in plantations are infected.

The grass, *Calamogrostis canadensis,* commonly called bluejoint, appears to be a serious competitor of seedlings of both conifers and hardwoods. On many sites, it prevents the adequate regeneration of trees. In some planted areas, it is overtopping the seedlings and, combined with snow, is pressing them to the ground and, in effect, smothering them. In one stand near Fairbanks, blade-scarification which exposes a mineral soil seedbed, has resulted in adequate, natural white spruce regeneration compared with no regeneration where there was no scarification. *E. C. Packee.*

Predicting the Growth and Yield of Forest Stands in Interior Alaska

Growth and yield information is essential for managing effectively the tree species of interior and southcentral Alaska. Early efforts concerning tamarack are continuing. Current emphasis is on locating stands suitable for stem analysis for the construction of site index curves; stands containing trees over 50 years of age are relatively uncommon in the more accessible areas of Alaska.

More than fifty plots of paper birch with a minimum age of least 50 years were sampled for site index information. Four trees were cut from each plot for stem analysis. Sampling and analysis are scheduled for completion during 1988.

Three (two white spruce and one tamarack) levels of growing stock (LOGS) plantations were established in the spring of 1986. These were measured for growth and survival in the fall of 1986, spring of 1987, and fall of 1987. Preliminary assessment of the data suggests that spruce remains in planting "check" for at least two years; height growth has been minimal. Tamarack, however, appeared to be coming out of check during the 1987 growing season. These LOGS plantations are the most northern in North America and should provide the forest manager with long-term survival information, growth and yield information, and optimum spacing guidelines. It should also provide the researcher with a basis for comparing results of other studies established much further south.

Analysis of specific gravity and energy content of tree species was delayed during 1987; analyses should be completed in early 1988. *E. C. Packee.*

Analysis of Long-Term Forest Productivity Using Computer Simulation Models

There is a common misconception that, because boreal regions are cold and often underlain by permafrost, that soil-moisture deficits are never low enough to affect forest growth. This condition may occur in areas where permafrost impedes drainage and results in either standing water on the surface or a perched water table just a few centimeters below the surface. However, in areas of discontinuous permafrost or where permafrost is entirely absent, forest distribution and growth is controlled by soil-moisture and nutrient availability.

Two thinning and fertilization studies were established to evaluate the question of nutrient limitation to tree growth and the consequences of stand manipulation for soil-moisture supply. The first in 1969 and the second in 1971. These studies have been monitored yearly through 1987. Results indicate that thinning is necessary to obtain a growth response to fertilizer. The response to fertilization lasted for 4 years after fertilization ended in plots thinned to 800 stems per hectare, while a significant response continued for only 2 years in plots thinned to 1600 stems per hectare.

A soil-water balance model was calibrated for the control and treatment plots of these two studies. Soil-water deficits were estimated and correlated with average basal area growth per tree. Results indicated that there is a correlation between seasonal soil-moisture deficit and growth during the years when soil moisture was measured for the unthinned control plots (r^2=0.787, p=0.002 that r^2=0), but not for the thinned and fertilized plots. (r^2=0.652, p=0.057 that r^2=0.) *J. Yarie.*

Twig and Foliar Biomass Profile for Understory Vegetation of Forested Communities of Southeast Alaska

The vertical understory biomass profile of forested communities in southeast Alaska can be estimated by applying equations developed in this study to the percent cover estimates obtained by US Forest Service survey crews. The percent cover estimates are obtained on their H-V plots. These equations differ from standard percent cover biomass relationships in that the vertical height of the layer estimated is also controlled. Therefore biomass can be estimated by 0.1 meter layers. *J. Yarie.*

Forest Products

The northern forest (spruce-birch-aspen-poplar) resource of Alaska is greater than that of Minnesota and slightly less than that of Wisconsin. Both Minnesota and Wisconsin have viable forest industries which include sawmills, pulpmills, waferboard plants, and fibreboard mills. In Minnesota, there is a chopstick plant which exports its product to Japan. Alaska has only a very small sawmill component for an industry. The potential for development of the resource into a viable forest industry capable of competing for world markets is strongly debated. Minnesota and Wisconsin compete in the world marketplace, and their forests provide employment for their citizens. Both states have a major commitment to the forest industry.

A major impediment to marketing northern forest species from Alaska is confusion and, in some cases, prejudice concerning the lumber and fiber characteristics. Furthermore, there is little commitment by the state or industry to the establishment and development of a competitive forest industry. During late 1987, the University of Alaska committed funds from the investment income from the university's trust lands to initiate more intensive work on industrial development of the northern

Alaskan forest. The goal of this effort is to provide data and information essential to the sound management, harvesting, manufacturing, and marketing of Alaskan forest products with emphasis on 1) northern forest species, 2) increased employment for Alaskans, 3) fullest utilization of the forest resource consistent with long-term productivity, and 4) increased competitiveness in the world market place.

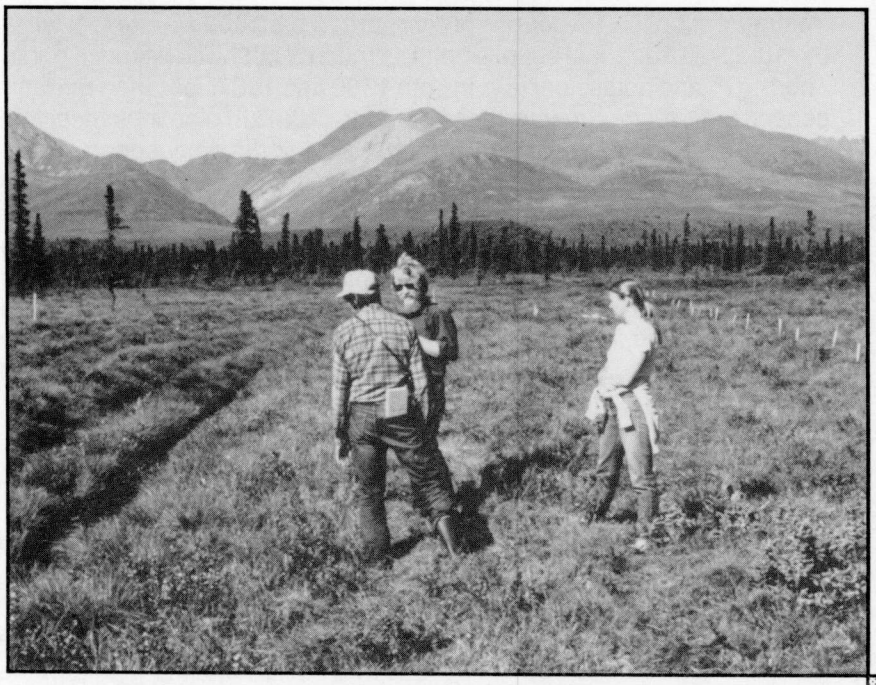
A review of stumpage-appraisal systems used in interior Alaska, Yukon , and interior British Columbia was completed during 1987 and was accepted as a masters thesis by the School of Management of the University of Alaska Fairbanks. Each political unit uses a different appraisal method: Alaska uses transactions evidence appraisals which are based on fair market value as determined by sufficient past competitive bids; Yukon uses administered prices which are arbitrary and restrict capture of the fair market value of stumpage; and British Columbia uses residual value appraisals which determine the stumpage price as the end-product price less the costs of production, profit, and risk. In addressing the British Columbia appraisal system, the British Columbia forest land tenure was also reviewed since tenure commitments can impact appraisal methods and prices.

During 1986 and through 1987, the concept of forest management agreements became an issue in Alaska. Knowledge of the tenure systems in British Columbia, Alberta, and Ontario provided information for debate. A brief paper, "Forest management agreement: The Canadian experience applied to Alaska," was presented at a public forum which identified some of the controls essential for forest management agreements to work in Alaska. With proper controls and commitment, forest management agreements can support and even encourage the development of a world class forest industry and thus benefit Alaska in terms of attracting capital, providing local employment, stabilizing the economy, and developing healthy, productive forests. *E. C. Packee.*

International Union Of Forestry Research Organizations Working Party S1.05-12 Northern Forest Silviculture And Management

The main goal of the International Union of Forestry Research Organizations (IUFRO) is "to promote international cooperation in scientific studies embracing the whole field of research related to forestry, including forestry operations and forest products." Working Party S1.05-12 became established in early 1985 as a result of a request by the High-Latitude Forestry group, initiated by the School of Agriculture and Land Resource Management in the late 1970s. The goals of the working party are essentially the same as the general goals of IUFRO except that emphasis is on the northern forest, also referred to as the boreal forest or taiga, of North America, Europe, and Asia.

The ninth symposium was held in Lapland, Finland, during August 1987 with speakers from the United States, Canada, Norway, Sweden, Finland, Russia, the People's Republic of China, Great Britain, and West Germany. Symposia proceedings are in preparation. The Tenth Annual Symposium is scheduled for Heilongjiang Province in the People's Republic of China for early September 1988. The Eleventh Annual Symposium is scheduled for Newfoundland, Canada, in mid-August 1989. The Twelfth Annual Symposium is planned for Quebec-Ontario, Canada, in August 1990. *E. C. Packee.*



Variety trials and management studies conducted at the Agricultural and Forestry Experiment Station continue to enable researchers to provide Alaskans with recommendations for grasses for many uses, including landscaping, reclamation, and forage.

Resources Management

Variety Trials and Management Studies With Turf Grasses

The variety 'Nugget' Kentucky bluegrass was released in 1966 for turf use in Alaska. Development of the variety, based on an Alaskan collection, was the result of cooperative efforts by USDA Agricultural Research Service scientists and university scientists at the Palmer Research Center of the Alaska Agricultural and Forestry Experiment Station. Nugget proved to be the premier turf grass for use in Alaska and also found favor at other north-latitude locations, including applications in some northern states where it is maintained in commercial production.

In turf trials conducted at the Palmer Research Center over 20 years after its release, Nugget is still judged to be superior to other commercially available varieties with which it has been compared. Nugget's superiority derives from its winterhardiness and the development of a dense turf with a dark green color.

Grasses that have produced high-quality turfs in some years simply have not endured as well as Nugget; they have been more erratic from year to year. In 1986 in two different trials, 'Dormie', a varietal release out of Canada based on material collected near Murmansk, Russia, appeared equal to Nugget in winterhardiness and superior in early spring growth (Nugget can be slow to "green up" in the spring). However, in 1987, in the same two trials, Dormie showed much more winter injury than Nugget and required much of the summer for recovery. During the winter of 1986-87, Nugget demonstrated greater tolerance to severe icing conditions than did the other commercially available Kentucky bluegrasses in the trial. The variety 'Touchdown' approached Nugget in quality in 1987, but it has shown serious injury in other years. Some experimental bluegrasses were about equal to Nugget in quality and hardiness. These are under further study.

In a study on fertilizer management, late-summer fertilizer treatments have been tested on a planting of turf grasses. The effect of applying either 20-10-10 or 10-20-20 about September 10 in 1985 and 1986 was evaluated in the following seasons of growth. The 20-10-10

treatment supplied 1.5 pounds of nitrogen (N) per 1000 square feet while the 10-20-20 treatment supplied half as much N but twice as much phosphorus (P) and potassium (K). In both 1986 and 1987, following the late-season fertilizer treatments, those portions of the turf plantings receiving the late-season treatments were judged superior in early spring quality and subsequent growth relative to those portions that did not receive the late-season fertilizer treatments. Further, the treatment supplying high N and low P and K was judged superior to the treatment with the reverse proportions. The grasses receiving the late fertilization appear to come out of the winter with more energy immediately available than those without the treatment. This trial was conducted in an area where snow mold are not a problem; there may be a question about late fertilization rendering grasses more susceptible to snow mold. *Wm. W. Mitchell.*

Microbial Biomass And Activity in a Subarctic Soil Ten Years after Crude Oil Spills

This study was conducted to determine the residual effects of two 10-year-old oil spills on soil microbial biomass and activity, and on carbon (C) and nitrogen (N) cycling in an interior Alaska black spruce forest. Winter and summer experimental hot crude oil spills were done at the site in 1976. In 1986 and 1987, we measured soil adenosine triphosphate (ATP) levels as indices of microbial biomass, *in vitro* carbon dioxide (CO_2) evolution, cellulose (filter paper) and ligno-cellulose (birchwood spatulas) decomposition rates, total and soluble soil N, soil C, and petroleum residues. Substantial amounts of petroleum residues remained in the soil and no reinvasion of plants had occurred in the area heavily impacted by the spills. Soil ATP levels in the unoiled control soil were about threefold higher than in the oiled soils, indicating reduced microbial biomass in the oily soils. There were no differences in *in vitro* CO_2-C evolution rates between the oiled and unoiled soils, suggesting that there were similar levels of available substrate in the soils. Nonpetroleum organic C levels were also similar in the oiled and control soils. Since there was probably little or no addition of organic substrate to the plant-denuded oiled soils during the decade following the oil spills, these data indicate that very little decomposition had occurred in the oiled plots. Cellulose and wood decomposition rates in the field were much lower in the oiled plots than in the unoiled soil. Total N levels were significantly higher in oiled soil than in the control soil. This may have been due to N deposition from parts of plants killed by the oil and to N_2 fixation, coupled with reduced N losses in the oiled soils. Ammonium-N accumulated in the oiled soils at much higher levels than in the control soil. Results of this study showed that crude oil spills in subarctic forests can have long-lasting effects on soil biological properties. *S. D. Sparrow and E. B. Sparrow.*

Genesis and Classification of Volcanic Ash Soils in Alaska

The classification and land-use interpretation of volcanic ash soils are important in Alaska because of their extensive distribution. Research projects were initiated in 1985 to study the morphological, chemical, physical, and mineralogical properties of those volcanic ash soils in southcentral Alaska. These studies are in cooperation with USDA-Soil Conservation Service and Forest Service, and Tohoku University, Japan. As a result of the cooperative efforts, a new suborder of Cryand was adopted by the International Committee on Andisols (ICOMAND) to accommodate all volcanic ash soils in the cryic temperature regime. A proposal to modify the great groups and subgroups of Cryand was

presented to the Ninth International Soil Classification Workshop in Japan, July 1987. The revised great groups include Placocryands, Hydrocryands, Melanocryands, Fulvocryands, Vitricryands, and Haplocryands. The proposal was then incorporated into the ICOMAND Circular No. 10 for field testing worldwide. Volcanic ash soils are unique in Alaska because they exhibit the characteristics of both Andisols and Spodosols. A cooperative study is now in progress to solve the Andisol/Spodosol transition problems. The research in soil genesis and classification in Alaska will contribute to the US Soil Classification System (Soil Taxonomy) in modifying or refining the taxonomic categories of cold soils, especially the volcanic ash soils in Alaska. The revised taxonomic categories will be used to guide the making and interpretations of soil surveys in the state. *C.-L. Ping.*

Physical Properties of Volcanic Ash Soils in Alaska

Volcanic ash soils have unique properties such as exchange complex dominated by amorphous material, low bulk density, high moisture retention, and irreversible aggregation upon drying. These properties were used for classification criteria in the provisional Andisol order. Soil samples from more than forty sites were taken across southern Alaska from the Aleutian Islands, Alaska Peninsula, Susitna Valley, Kodiak Island, and Baranof Island. The study is in cooperation with USDA Soil Conservation Service.

Soil textures are determined by the particle-size distribution analysis (PSDA). Current PSDA procedure requires oven-drying of samples before weighing. The oven-dry process was found to cause incomplete dispersion of soil particles, mainly the clay fraction. A comparative study using ultrasonic dispersion by Tohoku University of Japan has shown that the clay content is two to five times the value found by the traditional PSDA procedure. The bulk density of most volcanic ash soil horizons ranges from 25 to 56 pounds per cubic foot. Though most volcanic ash soils have a silt loam texture, they have a very high water retention. The water retention increases with the age of the ash fall and mean annual precipitation. The water retention at 15-bar pressure of field-moist samples ranges from 30 to 60 percent in southcentral Alaska to over 100 percent in southeast Alaska. However, these soils will lose most of their water-retention ability upon air-drying. The water retention decreased to 15 to 30 percent in southcentral Alaska and to less than 60 percent in southeast Alaska. Most volcanic soils will lose their plasticity upon drying due to aggregation of soil particles. The reduced water retention, plasticity, and clay content upon drying are caused by the irreversible aggregation of soil particles. The agent for such aggregation is allophane, which is amorphous clay mineral, and is common to weathered volcanic ashes in Alaska and elsewhere in the world. *C.-L. Ping.*

Potential of Horticultural Peat In Alaska

Half of the peat resources of the US is located in Alaska, and it has been estimated that the peat reserves exceed the oil and gas resources of the state. At the current oil price, it may not be economical to use it as an alternative energy source, but it is practical to use peat for horticultural purposes. Fibrists are identified as the most desirable peat for such purposes because of their high fiber content. In addition to in-state use, there is also great potential for export markets in the continental US and the Pacific Rim countries.

The purpose of current research is to test the physical and chemical properties of local peats and to evaluate their performance in greenhouse and growth-chamber studies. Results from the preliminary studies indicate that the Lemeta peat mixed with sawdust and sand performed equally well in comparison with imported potting mixes. Both cabbage and spinach were used as indicator species in growth-chamber studies to test the lime requirements of three peats from Fairbanks, the Kenai Peninsula, and the Susitna Valley. The results indicated that lime is not required. All three sources of peat tested have physical and chemical properties comparable to the imports except for a higher ash content. The higher ash content indicates excess mineral particles in the peat due to mixing of mineral horizons during excavation. Further study is planned for characterization of undisturbed peats in interior and southcentral Alaska. *C.-L. Ping, G. J. Michaelson, and H. C. M. McIntyre.*

Farming Systems Research Applied to Agriculture in Alaska

A research program using the techniques of Farming Systems Research (FSR) seeks to place the farmer at the core of the research effort. This includes understanding the biological, economic, social, and political constraints facing the farmer and removing or mitigating these constraints. A first step in this process was begun in cooperation with the Department of Geography in 1986. This first step is to describe the physical characteristics and agribusiness infrastructure of Alaska's agricultural industry. Statistical information concerning the industry has been provided by the Alaska Crop and Livestock Reporting Service since 1953. Although statistics are an excellent source of information, they do not provide a historical insight into events which might have effected rises and falls in product quantities and values.

The parameters of concern in this ongoing research are: value of production at the farm level, volume of production, and acres utilized. Historical literature concerning political and economic conditions statewide for the same period is being collected and reviewed with particular attention given to national and worldwide events. The purpose is to first develop an understanding of what have been the driving forces behind agricultural production, and, second, to determine what product or group of products play a dominant role.

The first industry within Alaska's agribusiness sector chosen for evaluation was the dairy industry. The dairy industry today is a dominating factor in Alaska's agricultural sector. Receipts from the industry made up 21 percent of all farm receipts in Alaska in 1986. The dairy industry had its beginnings in the Matanuska Valley in the mid 1920s. There was a renewed interest in the late 1970s as a part of a general effort toward development of an agricultural strategy for Alaska. The dairy industry has sustained for over a 50-year period in Alaska and renewed efforts toward expansion appear to be successful. A key to this success is the fact that the infrastructure for processing of milk and movement of the products was almost entirely in place when implementation of an expansion strategy began. *C. E. Lewis and R. W. Pierson.*

Economics of Land Use

A common perception of Alaska is one of nearly unbounded wildlands where the marginal value of open space is insignificant. At the same time, however, it has been suggested that in residential areas of the state's population centers, environmental amenities associated with creeks, parks, and other open areas may contribute to the value of adjacent real estate. Policies and regulations to invest in and otherwise maintain natural open areas have become part of the agenda of public land-use controls.

Using a hedonic price model, an attempt was made to isolate the net contribution of Noyes Slough in Fairbanks to adjacent residential lot values. The regressions established the independent effects of various housing and locational characteristics on sales prices; however, proximity to open space provided by the slough was not found to be a significant determinant of value in this case study. The result may be due to an abundance of open space in the general study area. Alternatively, the historically negative image of the slough due to increased mosquito nuisance and basement flooding from the high seasonal water table may offset any positive influence on property values.

Under Alaska state law, properties are to be assessed for tax purposes at 100 percent of market value. Data from the Noyes Slough study were used to test the proposition that assessors were accurately reflecting market values in their assessments. The results revealed a high linear correlation (in excess of 0.90) between assessments and sales values. Further, these data suggested a consistently close agreement between market values and assessments throughout the observable range of sales values. *W. G. Workman.*

Recreation Management

Work continued a the theoretical model for recreational opportunities. The National Petroleum Reserves, Alaska, project was completed. It delineated the recreational opportunities within the reserve, and assessed the potential impact of oil and gas development on those lands. A similar project was completed on wild river planning. A basic model was synthesized and tested using Birch Creek and Beaver Creek National Wild Rivers.

The data analysis on a sled dog study is nearly complete. The study assessed user preferences for management programs related to dog mushing, and estimated expenditures and benefits related to mushing.

Two publications on recreation economics were published, as well as one journal article on a previous trail-erosion study. Future direction will be focused more on winter recreation. *A. Jubenville.*

Who's Planning Alaska: The Alaska Planning Directory

Most of Alaska is publicly owned land. Federal, state, and local agencies responsible for this land are required to prepare management plans. Each agency, however, prepares plans in a somewhat different way, with different terms and procedures. The Alaska Planning Directory is the primary source of current information about the planning agencies and their plans.

The directory was first published in 1985 with an updated and expanded edition in 1987. Copies are available from the Cooperative Extension Service, University of Alaska Fairbanks. The third edition of the directory is expected to be published in early 1990 *T. Gallagher.*

Procedures for Solving Group Problems

This research began in 1985 with a literature review of both applied and theoretical planning and problem-solving procedures. In 1986, the study focused on the Colorado Joint Review Process (CJRP), a special procedure that Colorado uses to eliminate confusion during the planning and permitting of mega-projects. The study concluded that the CJRP was highly effective, in part because it was cyclical in character. Results of the study have been submitted to the Alaska Office of Governmental Coordination, which is considering the process for use in Alaska. A formal paper presenting the results of the study was published in the journal "Environmental Management" in 1987.

In 1987, this research shifted its focus toward another cyclical procedure for solving group problems—"the cycle process." The process is a variation of one developed by Applied Environmental Research of Ann Arbor, MI, in the 1970s. The process has proved effective at solving group problems because it is easy to learn, offers a high level of useful feedback between participants, saves time and money, and dramatically reduces the potential for post-process litigation. The process is most applicable to land-use and land-development planning, but it has also been used in other group problem-solving situations. The process is currently being used by a regional Native corporation to prepare land-use plans for each of its villages. A book about the process, *Problem Solving with People: The Cycle Process* was published by University Press of America in 1987. *T. Gallagher.*

Arctic Land Planning: Time for Circumpolar Coordination

Study continues on land planning in other Arctic countries. To date emphasis has focused on Canada, but some information has also been gathered on the Scandinavian countries and the Soviet Union. An informal meeting of several land planners and managers is scheduled for June 1988 at the Arctic Institute of North America in Calgary, Alberta. Discussion at this meeting will focus on the potential for preparation of an Arctic Land Planning Directory and possible formation of an association of Arctic land planners. *T. Gallagher.*

Participation in Planning: Getting Citizens Involved

This research program began in late 1986 with a "Delphi" study of agency concerns about land management in Alaska. The primary concern of agency planners was how to make their public-participation programs more effective. Two major studies emerged from this discussion.

The first study concerned reasons why the Native people of Alaska were not easily involved in the planning process. The study quickly found obvious problems, such as the difficulty of traveling to meetings in rural Alaska. But a review of cross-cultural literature identified three more-subtle problems. The first is a world view among traditional Native people that does not readily accept either active land management or planning. The second is an informal style of decision making in the community that does not blend with formal agency procedures. The third is differences in communication styles that make discussions between Native people and non-native planners difficult. The results of this study are to be published in the journal *Arctic* in June 1988.

The second study concerned the readability of the agency land-management plans. All of the major plans in Alaska were tested for

reading difficulty using a series of standard indexing methods. The plans have been found to be written at or above the junior year in college. The average person, however, reads at about the eighth grade level. The readability gap is thought to be excessive and may have serious implications for public participation in planning decisions. A paper presenting the results of the study has been accepted for publication by the journal *Environmental Management. T. Gallagher.*

Irradiation of Alaskan Food Commodities

The overall goal of this feasibility study (conducted for the state of Alaska and coordinated by the Institute of Northern Engineering) is to evaluate the potential social and economic benefits and risks that may be realized from the application of food-irradiation technology to Alaska's seafood and agricultural products. Potential benefits include increased shelf life, allowing commodities to be shipped greater distances as fresh products without degradation of product quality, and decreased naturally occurring disease-carrying microorganisms that are of public health concern. Treatment of Alaska-produced food products may benefit the seafood and agricultural industries by opening new markets both in-state and worldwide for these value-added products. A potential added benefit to Alaskan consumers is a safer and more varied food supply. Utilization of presently discarded by-products from the seafood and agricultural industries would also eliminate some environmental concerns and increase total product value.

Irradiation is a physical process as are canning, freezing, drying, and pasteurizing. During the irradiation process, foods are exposed to an ionizing radiation source. Ionizing radiation passing through the food breaks chemical bonds in undesirable microorganisms. It destroys bacteria, yeast, and molds. Irradiation can kill or sterilize insects, and it can retard further ripening of fruits and vegetables. Because irradiation increases the temperature of food only a few degrees, fresh foods retain their appearance, texture, and flavor. However, because a few (6 out of 10,000,000) chemical bonds are also broken in the food, some small quality changes occur. For example, irradiated dried vegetables cook faster, meat is tenderized, and solanin, a naturally occurring toxin in potatoes, is not formed. Potatoes, strawberries, mangoes, frozen fishery products, and grains are among the food products irradiated in some foreign countries.

Irradiated foods are not radioactive, and the consumer is never exposed to radiation. The approved processing procedure has little effect on nutritional quality. Recent studies show no harmful effects from eating irradiated foods even when 100 percent of an individual's diet is irradiated food. Scientifically conducted animal studies also show no toxic effects.

In the United States, the Food and Drug Administration determines what foods can be irradiated, at what levels, and for what purposes. Approval for wheat, wheat flour, and potatoes dates from the 1960s. Irradiation of pork, dehydrated spices, herbs, teas, vegetable seasonings, and fresh produce has been approved since 1984. Some spices are disinfested using radiation. In test markets, irradiated tropical fruits have sold well; appearance and quality of these fruits encouraged consumers to purchase them. Labeling is required so that consumers can select among available products.

The food-irradiation process is regulated under Federal and state food safety and good manufacturing guidelines. Workers and training and safety procedures are governed by state and Federal guidelines.

International standards for the operation of food-irradiation facilities have been established by the United States.

Machine-generated beams of electrons or X-rays and gamma rays from isotopes such as cobalt-60 or cesium-137, can be used as radiation sources. Machine sources are attracting increased interest because they eliminate many environmental and safety concerns. If a facility were to be built in Alaska, machine sources are recommended for use. Safety in design, construction, and operation would be of primary importance. *R. B. Swanson, C. E. Lewis, and W. G. Workman.*

Assessment of Local Vocational Programs

The agricultural education specialist at SALRM was involved in a major effort to assess vocational programming in Fairbanks schools. The local Vocational Advisory Council, lay citizens representing various disciplines within the vocational programs, served as the steering committee for the study. Thirteen program committees, involving participation of over one hundred local residents representing local business and industry, reviewed individual vocational programs and prepared a detailed report for the Advisory Council. In turn, the Advisory Council prepared a synopsis report for presentation to the superintendent of schools and the school board.

The major recommendations were to: 1) establish advisory committees for each vocational program, 2) refine the vocational program to better meet student and community needs, 3) promote vocational education as both valuable and necessary for all students, 4) establish career awareness and career exploration curricula at all school levels, 5) implement quality vocational counseling in each school, 6) improve program articulation both horizontally and vertically, and 7) provide centralized vocational leadership with authority. All recommendations were considered paramount, thus a priority ranking is not intended.

To expedite implementation, short-term actions, mid-term possibilities, and long-term effects were identified for each recommendation. The advisory council's plan of work through the 1988-89 academic year is to implement as many of these recommendations as possible. *C. Kirts.*

New State FFA Rituals Contest

A state FFA Rituals Contest has been prepared for use in Alaska. The purpose of the contest is to encourage younger members of the Future Farmers of America (FFA) to participate in state convention activities by demonstrating their proficiency in performing the official opening and closing ceremonies for meeting.

Published rules, procedures, and scoresheets were piloted at the 1987 Alaska State FFA Convention. With several revisions, the contest is now available and approved for use as an official state contest. This is the fourth in a series of agricultural education publications developed at the University of Alaska Fairbanks. *C. Kirts.*

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Financial Statement

Expenditures — July 1986 through June 1987

The following is a statement of expenditures of Federal and state funds for the fiscal year beginning July 1, 1986, and ending June 30, 1987 (FY 87).

		(% of total)
Federal		
Hatch Regular Formula Funds	634,460	10.7
Hatch Regional Formula Funds	94,907	1.6
USDA–Agricultural Research Service	231,824	3.9
McIntire–Stennis Formula Funds	177,888	3.0
Other Grants and Contracts	958,290	16.2
State Funds	3,823,398	64.6
TOTAL	5,920,767	100.0

University of Alaska – 1987

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Professional Staff

Cathy A. Birklid, Research Assistant; University of Alaska '77, A.A., B.B.A. Ms. Birklid began working for AFES in 1979. Her major responsibilities have included development and administration of market surveys concerning statewide demand for various agricultural products. Ms. Birklid is now utilizing statistical software packages to analyze the effects of tillage methods, straw treatments, nitrogen fertilizer source, and seeding methods on barley production in the Delta area. She is currently examining the transportation network for seafood and agricultural commodities produced in Alaska.

Leroy Ben Bruce, Assistant Professor of Animal Science; New Mexico State University '74, B.S., '78, M.S., '79, Ph.D. Dr. Bruce was previously with the University of Hawaii at Hilo and South Dakota State University. Dr. Bruce's work in Hawaii was primarily teaching and research in such unusual feedstuffs as taro. In South Dakota, he was extension specialist in feedlot nutrition, providing service to cattle feeders statewide. His work with AFES is with beef cattle at the Palmer Research Center. His general areas of research interest are beef cattle nutrition and management; he is working specifically with cow-calf and feedlot research.

Vivian L. Burton, Laboratory Supervisor; University of Alaska '71, B.S. Mrs. Burton was a cytology technician from 1958 to 1960 at Texas A. and M. where she worked in cancer research and stain technology. From 1960 to 1962 she worked in veterinary research at Montana State University. She began work as a soil science technician at the AFES Palmer Research Center in 1964, and in 1968 she became a technician in the Animal Science Department there, leaving in 1969 for further study in Fairbanks. Mrs. Burton returned to the Animal Science Department in Palmer in 1973. She retired in 1987.

Donald E. Carling, Associate Professor of Horticulture; St. Cloud State University, Minnesota '67, B.A.; University of Missouri–Columbia '69, M.S., '75, Ph.D. Dr. Carling's research background is in plant pathology with emphasis on ultrastructural studies, plant endomycorrhizal relationships, and diseases of vegetable crops. He joined AFES in 1981 and has since concentrated a basic and applied research program on potatoes and vegetables. Applied research with potatoes includes variety testing and evaluations of cultural practices. Applied research with vegetables includes variety trials, nitrogen fertilization studies, and evaluation of transplanting as an alternative to direct seeding. Other basic research includes the study of root disease of potatoes and vegetables caused by *Rhizoctonia solani* and of the taxonomy of this important soil-borne fungus.

Verlan L. Cochran, Soil Scientist, USDA; Affiliate Associate Professor of Agronomy; California State Polytechnic College '66, B.S.; Washington State University '71, M.S. Mr. Cochran's research interests have included gaseous losses of fertilizer nitrogen, nitrogen transformations in soil, nitrogen use efficiency, fertilizer management and interactions of crops and weeds, and water-use efficiency in supplemental irrigation of dryland wheat. Mr. Cochran joined the AFES staff in 1985 after nineteen years with USDA Agricultural Research Service at Pullman, Washington. His work with AFES is on crop-residue management in reduced tillage for interior Alaska.

Jeffery S. Conn, Research Agronomist, USDA; Affiliate Assistant Professor of Weed Science; University of Arizona '73, B.S., '76, M.S.; North Carolina State University '80, Ph.D. Dr. Conn's background of research is in weed science, physiological ecology, and remote sensing. He joined the Agricultural Research Service at the University of Alaska in 1980. His current research is in integrated weed control systems for reduced-tillage agriculture, weed biology and ecology, and persistence of herbicides.

Robert F. Cullum, Assistant Professor of Agricultural Engineering; University of Tennessee, Knoxville '77, B.S., '82, Ph.D. Dr. Cullum's research background is in the areas of structure in relation to environment and soil and water engineering. He joined the AFES research faculty in 1982 and has since concentrated on conservation-tillage research in small-grain production for interior Alaska and waste-management systems for Pt. MacKenzie in southcentral Alaska

Robert A. Dietrich, Professor of Veterinary Science, Institute of Arctic Biology, University of California-Davis '61, B.S., '63, D.V.M.; Post-graduate training, University of Alaska Fairbanks, '68. Dr. Dietrich's research interests include: diseases of wildlife, applied methods for disease control in reindeer, methods for disease control in fur farming, equine medicine, and surgery.

James V. Drew, Dean, School of Agricultural and Land Resources Management, and Director, Agricultural and Forestry Experiment Station; Rutgers University '52, B.S., '57, Ph.D. Dr. Drew began his professional career at the University of Nebraska-Lincoln where he became professor of agronomy and, later, dean for graduate studies. His research in agriculture emphasized soil genesis and classification and plant-soil relationships, as well as interpretations of soil surveys for agriculture and land management. Dr. Drew came to his present dual position in 1976. He is an American Society of Agronomy Fellow and an American Society for the Advancement of Science Fellow and has received numerous state and local civic and government appointments since joining SALRM.

Mayo Earnest, Publications Supervisor and Public Information Officer, SALRM, attended the University of Connecticut and the University of Alaska. Mrs. Earnest has been with the University of Alaska since 1973 and with SALRM since 1976. As head of publications, she oversees the production of the station's journal, *Agroborealis,* as well as a variety of other publications; as information officer for SALRM, Mrs Earnest provides information to many agencies and publics.

Alan C. Epps, Professor of Natural Resources; Montana State University '66, B.S.; Montana State University '69, M.S. Mr. Epps's background is in natural-resources allocation and management, with extensive experience in land-use planning. Before joining AFES he was with the Cooperative Extension Service, University of Alaska, where he worked extensively in public policy at the national, state, and local levels, receiving the USDA Distinguished Service Award in 1978 for his policy education work on the Alaska national-interest lands issue. Mr. Epps conducted research on natural resource policy, and coordinated UAF's applied reindeer research and instruction program, and taught an upper-division course on the Alaska reindeer industry. He retired in December 1987.

John D. Fox, Jr., Assistant Professor of Land Resources; Trinity College '68, B.S.; University of Washington '70, M.S., '76, Ph.D. Dr. Fox came to UAF with experience in remote sensing and computer modeling in forest hydrology. He worked with the Institute of Water Resources on several projects including snowmelt-soil moisture interactions, modeling of air pollution, aquatic ecosystems, lake-level changes, and watershed geomorphology. Dr. Fox has continued his research interests in land-use hydrology and modeling natural resource systems with AFES, currently researching runoff relations of boreal forests. He teaches courses in watershed management, forest systems, forest management, resource measurements, simulation and modeling, and biometeorology.

Thomas J. Gallagher, Assistant Professor of Regional Planning; University of Oregon '69, B.L.A.; University of Michigan '74, M.S., '77, Ph.D. Dr. Gallagher's research interests are in the area of planning processes, participation methods, and rural land planning. He is presently conducting research on participation of Native peoples in planning. He teaches graduate courses in regional planning and undergraduate courses in land-use planning. Dr. Gallagher also serves with Cooperative Extension Service as a land-resource specialist. He has recently published *Who's Planning Alaska: The Alaska Planning Directory* with CES and *Problem Solving with People: The Cycle Process* with University Press of America.

Anthony F. Gasbarro, Extension Forestry Specialist and Associate Professor of Extension, Cooperative Extension Service; Colorado State University '62, B.S.; University of Alaska '79, M.S. Mr. Gasbarro has worked in the areas of forest management, international forestry development, land-use planning, and extension forestry. He worked for five years with the US Forest Service both in California and Alaska, two years with the Peace Corps in the Dominican Republic, and two and one-half years with the Food and Agriculture Organization of the United Nations in Rome, Italy. Since joining the university staff, Mr. Gasbarro has served as a forestry and land-use planning instructor and researcher.

Charles W. Hartman, Executive Officer; Rutgers University '64, B.A.; University of Alaska '67, B.S. Mr. Hartman worked as a research engineer and hydrologist for the Institute of Water Resources from 1967 to 1974. In 1974, he became IWR's executive officer where he continued until 1979 when he transferred to SALRM in the same capacity.

Dorothy J. Helm, Plant Synecologist, Research Associate; University of Delaware '69, B.S.; University of Michigan '70, M.S.; Colorado State University '77, M.S., '81, Ph.D. Dr. Helm's research background includes soil-vegetation relationships and vegetation inventory techniques. She has studied vegetation communities and their successional, wildlife, and phenological relationships on the Susitna Hydroelectric Project. Her investigations on mining-disturbed lands have included premine inventory and ecological assessment of reclamation success. She has participated in grazing and wildlife studies at Homer and Delta Junction and has assisted agencies with range ecology observations. She has supported other projects as a statistical consultant and taught range management.

Mary Lou Herlugson, Research Associate in Animal Sciences; New Mexico Institute of Mining and Technology '74, B.S. Ms. Herlugson joined AFES in 1981 after five years in animal science research at Washington State University. She provides support to animal science faculty through data reduction, manipulation, and statistical and computer analysis and assists in design of research and interpretation of results.

Patricia S. Holloway, Assistant Professor of Horticulture; Millersville University of Pennsylvania '73, B.A.; Washington State University '76, M.S.; University of Minnesota '82, Ph.D. Dr. Holloway's research background is in pomology and fruit breeding with major concentration on domestication and cultivation of Alaska native plants. She joined SALRM in 1984 and teaches courses in plant propagation, plant tissue culture, and general horticulture. Her research involves the improvement of production of horticultural crops in Alaska with emphasis on the cultivation of Alaska native plants for ornamental and fruit-crop production.

Fredric M. Husby, Associate Professor of Animal Science; Washington State University '66, B.S., '69, M.S., '74, Ph.D. Since joining AFES in 1975, he has conducted nutrition research with cattle, dogs, sheep, and swine to determine the nutritional and feeding value of Alaska's barley and marine by-products, making it possible for AFES to make recommendations for feeding crab and fish meals to livestock. He has also investigated the value of chitin in ruminant rations. His current research is aimed at evaluating barley-protein quality and the feeding value of a new hulless mutant variety 'Thual' in swine and sled-dog rations. Dr. Husby has developed and offered courses in introductory animal science, livestock feeds and feeding, nutrition, and metabolism for undergraduates and graduates through the Natural Resources Management Program.

Alan Jubenville, Associate Professor of Natural Resources Management; North Carolina State College of Agriculture and Engineering '62, B.S.; West Virginia University '64, M.S.; University of Montana '70, Ph.D. Dr. Jubenville joined the school in 1979 after nine years at the University of Wyoming. His primary teaching and research interest is in outdoor-recreation management. He has developed a series of papers on basic management theory, authored several textbooks, and been involved in the study of several major state projects in Alaska, including Phase 1 of the Susitna Hydroelectric Project and the Kenai River Special Management Zone. He is the chairman of W-133 Regional Hatch Project, entitled "Benefits and Costs in Resource Planning." Dr. Jubenville has recently completed work on a textbook integrating theory into the management process during a recently concluded sabbatical leave.

Glenn P. Juday, Visiting Associate Professor of Plant Ecology; Purdue University '72, B.S.; Oregon State University '76, Ph.D. Dr. Juday's research background is in community ecology, especially composition, distribution, and structure of old-growth conifer forests. He was principal investigator, Indiana Natural Streams System in 1972. He was chairman of the Oregon Natural Areas Commission from 1973-76 and coordinator, Rosie Creek Fire Research Project, 1983-85. He has been coordinator of the Columbia Glacier Succession Study since 1985. Dr. Juday's major program responsibilities since joining AFES in 1982 have included coordination of multidiscipline research projects, especially the Alaska Ecological Reserves Program. He has received a Meritorious Service Award for natural areas work from the governor of Oregon and is now serving as president of the Natural Areas Association.

Carla A. Kirts, Assistant Professor of Agricultural Education; Virginia Polytechnical Institute and State University '76, B.S., '77, M.S.; University of Missouri-Columbia '81, Ph.D. Dr. Kirts's research background is in student-teaching management for preparation of vocational-agriculture teachers and strategies to promote quality instruction. Currently, Dr. Kirts teaches courses in natural-resources management, general agriculture, agricultural communications, and agricultural education. She also assists vocational-agriculture teachers with program planning and implementation. Dr. Kirts received the Honorary State Farmer Degree in 1983 from the Alaska Association of the Future Farmers of America (FFA) and the Honorary American Farmer Degree in 1986 from the National FFA.

Leslie J. Klebesadel, Professor of Agronomy; University of Wisconsin '54, B.S., '55, M.S., '57, Ph.D. Dr. Klebesadel joined the University of Alaska in 1957. He served as the first director of the Matanuska-Susitna Community College in 1958. As a member of the Plant Science Team of US/USSR Agreement on Agricultural Cooperation, he traveled extensively in the Soviet Union in 1974. He served as research leader and location leader of the USDA Agricultural Research Service scientific staff in Alaska from 1968 to 1981. Dr. Klebesadel's research emphasis has been in physiology and management of forage grasses and legumes; latitudinal, ecotypic, and photoperiodic aspects of adaptation, winterhardiness, and seed production; development of cold hardiness and dormancy; establishment techniques; nutrition and harvest management; evaluation and utilization of indigenous Alaskan grasses and legumes; and ecological physiology and genetics with regard to germplasm modification within introduced populations during natural selection toward subarctic adaptation. Dr. Klebesadel retired in July of 1987.

Charles W. Knight, Instructor of Agronomy; Kansas State University '70, B.S., '71, M.S. Mr. Knight's background in research is with chemical fertilizers and conservation tillage. He came to Alaska in 1971 and worked until 1973 as a research technician for AFES. From 1973 until 1978 he was superintendent of the East Central Kansas Experiment Field for Kansas State University. He returned to Alaska in 1978 to concentrate on soil- and water-conservation practices and fertility requirements in the Delta Agricultural Project. Mr. Knight is currently pursuing a Ph.D. degree in soil chemistry at the University of Alaska.

Gary A. Laursen, Adjunct Associate Professor of Mycology; Western Washington State University, Bellingham, '65, B.A.; University of Montana, Missoula '70, M.S.T.; Virginia Polytechnic Institute and State University, Blacksburg, '75, Ph.D. Dr. Laursen's background includes teaching, research, and research administration in the Arctic, specifically at the Naval Arctic Research Laboratory in Barrow and currently with a research appointment at AFES. His research interests include studies of fungi in Arctic, alpine, and maritime tundra sites in Alaska, Norway, Sweden, Finland, Russia, and Switzerland. Dr. Laursen's current interests emphasize Arctic Alaska fungal ecology, morphology, and taxonomy and interior Alaska higher-plant/fungi associations.

Carol E. Lewis, Associate Professor of Resources Management; University of Florida '62, B.S., '64, M.S.; Georgetown University '70, Ph.D.; University of Alaska Fairbanks '76, M.B.A. Dr. Lewis was previously active in research for the U.S. Navy, applying high-frequency sound technology in explosive and medical research. A member of the AFES research faculty since 1973, her research efforts have been primarily in controlled-environment agriculture, feasibility of small-grain and livestock operations in Alaska, and the economic impacts of agricultural development in the state. At present, she serves as project leader for conservation tillage research in small-grain production conducted in Delta Junction, concentrating on the efficiency of tillage systems in terms of energy use and cost of production. Her teaching responsibilities are in the area of farm management.

Jenifer Huang McBeath, Associate Professor of Plant Pathology; National Taiwan University, Republic of China '65, B.S.; University of California, Davis '70, M.S.; Rutgers University '74, Ph.D. Dr. McBeath's research background is in plant virology, plant mycoplasmology, immunology, insect tissue culture, and electron microscopy. Dr. McBeath's first faculty position, in 1977, was at the Institute of Arctic Biology, UAF, for work on rust diseases of spruce trees. She joined AFES in 1980 and is currently conducting research on fungal and bacterial diseases of wheat and barley plants, anther culture and protoplast fusion of winter wheat, cold-tolerant biological control agents of plant pathogens, witches' broom diseases of cottonwood and willow, spruce rusts, and wood decays. Dr. McBeath teaches courses in plant pathology and forest protection. She was an Associate Research Fellow, Academia Sinica, Republic of China, 1975; and a Postdoctoral Fellow, Thomas Jefferson University, 1976. In 1985-86, she was a visiting scientist at USDA-ARS, Beltsville Agricultural Research Center, Maryland.

Jay D. McKendrick, Associate Professor of Agronomy; University of Idaho '63, B.S., '66, M.S.; Kansas State University '71, Ph.D. Dr. McKendrick's Alaskan research activities include: tundra revegetation; secondary plant succession in Arctic tundra; fertility of tundra soils; oil-spill reclamation in Arctic and boreal zones; livestock, musk ox, and bison grazing; range plant nutritional qualities; hay quality; sand dune revegetation; Susitna Basin vegetation for a hydroelectric project; mine-spoil reclamation; the effects of burning on browse quality; and range plant quality for Sitka blacktail deer. He has served as a consultant to industry on matters relating to the effects on vegetation of development activities. Dr. McKendrick has also served as a member of the National Academy of Sciences Committee on Alaskan Coal Mining and Reclamation and as a staff advisor to the National Governors' Association Range Resource Subcommittee.

Gary J. Michaelson, Research Associate; University of Arizona '75, B.S.; Iowa State University '81, M.S. Mr. Michaelson has a background in agricultural chemistry and soil fertility. He has conducted his work in soil testing and plant-tissue analysis as Plant and Soil Analysis Laboratory supervisor at the Palmer Research Center. He is also currently working in soil fertility and fertilizer requirements of newly cleared Alaska soils.

G. Allen Mitchell, Associate Dean, School of Agriculture and Land Resources Management; Associate Director, Agricultural and Forestry Experiment Station; and Associate Professor of Agronomy; University of California, Riverside '71, B.S., '73, M.S., '77, Ph.D. Dr. Mitchell rejoined AFES in September 1987. He has previously served UAF as Agronomy Specialist with Cooperative Extension Service, and as Assistant Professor of Agronomy with AFES. Dr. Mitchell's advance degrees are in the area of soil science with emphasis in soil fertility. He brings experience to AFES from several land-grant institutions, including the University of Arkansas, where he was director of both the Northeast and Southeast Extension and Research Centers and head of the Agriculture Department, and from the University of Georgia, where he was assistant professor of agronomy.

William W. Mitchell, Professor of Agronomy; University of Montana '57, B.A., '58, M.A.; Iowa State University '62, Ph.D. Dr. Mitchell's research background is with grasses in natural ecosystems, with particular respect to ecotypical adaptation; he teaches courses in biological sciences. He joined AFES in 1963 when he commenced studies on native grasses of Alaska, investigating the taxonomy, distribution, adaptation, and cytological races of selected species. Dr. Mitchell's revegetation research in the Prudhoe Bay oil field, along the trans-Alaska pipeline route, and on Amchitka Island, lead to the release of native grass varieties for revegetation use. During 1987, he continued his studies on revegetation of surface-mined lands in interior and southcentral Alaska. His major activities have most recently included research on application and management of forage grasses in a number of agricultural areas in the state and turf studies at the Palmer Research Center. Dr. Mitchell retired at the end of 1987 after having served during that year as acting assistant director of AFES in charge of operations at the Palmer Research Center.

Bonita J. Neiland, Director of Instruction and Public Service, School of Agriculture and Land Resources Management; University of Oregon '49, B.S.; Oregon State University '51, M.A.; University of Wisconsin '54, Ph.D. Dr. Neiland's research background is in plant ecology with emphasis on soil-vegetation relations and forest regeneration. She is former head of the Department of Land Resources and Agricultural Sciences at UAF. In 1952, she was a Fulbright Fellow to the University of Wales. Dr. Neiland retired in June 1987.

Edmond C. Packee, Assistant Professor of Forest Management; University of Montana '62, B.S., Yale University '63, M.F., University of Minnesota '76, Ph.D. Dr. Packee's research background is in coniferous forests and in northern hardwood forests. He also has had forest management and silvicultural experience in northern Wisconsin and Canada. Dr Packee joined AFES in 1983 and has concentrated on forest growth and yield, the silviculture of tamarack, and forest products' markets. He is a member of the Alaska Forest Tree Improvement Cooperative's Technical Committee. He is chairman of the International Union of Forestry Research Organizations Working Party S1.05-12, Northern Forest Silviculture and Management.

Barbara J. Pierson, Research Associate, Soils; Montana State University '77, B.S., '85, M.S. Ms. Pierson's research and work experience has been directed toward soil fertility and soil-management problems. She was employed by the Soil Conservation Service prior to beginning graduate study. After joining the AFES staff in 1985, she has worked primarily with conservation-tillage systems and fertilizer management in research plots established in the Delta Junction area.

Chien-Lu Ping, Assistant Professor of Agronomy (Soil Scientist); Chung-Hsin University, Taiwan '65, B.S.; Washington State University '73, M.S., '76, Ph.D. Dr. Ping's research background is in soil chemistry; the movements of pesticides, heavy metals, and pollutants in soils; and related land-use issues. He was previously with the Washington State Department of Natural Resources, working on a statewide forest land-grading (survey) program to correlate forest productivity with soil types and to design soil-map units for urban planning in western Washington. He joined AFES in 1982 to investigate soil genesis and classification in Alaska. He also represents the experiment station in his participation in the National Cooperative Soil Survey program in Alaska. Dr. Ping is also involved in soil fertility research and the Statewide Soil-Testing Program.

Sigmund H. Restad, Assistant Director of the Agricultural and Forestry Experiment Station, University of Minnesota '53, B.S.; University of Minnesota '54, M.S. Mr. Restad's background includes agricultural extension, research in dairy nutrition and management, administration of the Alaska Division of Agriculture, and executive officer of AFES. Until his retirement in January 1987, his position included management of the Palmer Research Center.

Allen P. Richmond, IV, Research Associate, Forestry; Virginia Polytechnic Institute and State University '73, B.S.; University of Alaska '83, M.S. After serving four years as an officer in the United States Army, Mr. Richmond enrolled in the University of Alaska. Beginning in 1979, he worked in the Intensive Forest Management Program demonstrating and evaluating various pieces of forestry equipment and silvicultural practices which might improve the productivity of interior Alaska's forest lands. His research was directed toward determining forest-management options available to forest managers. Mr. Richmond left AFES in June 1987.

George R. Sampson, Research Forester, Institute of Northern Forestry; Iowa State University '60, B.S.; University of Delaware '63, M.S. Mr. Sampson's background includes forest products marketing and utilization research at three other USDA Forest Service regional experiment stations (Southern, Southeastern, and Rocky Mountain). His current research relates to identifying the potential for increasing utilization of interior Alaska timber for wood products and energy.

Peter C. Scorup, Research Associate; Colorado State University '66, B.S. Mr. Scorup was a range conservationist with the Soil Conservation Service for three years and an instructor of agriculture and natural-resources management at Colorado Mountain College for two years before joining the experiment station in 1972. His Alaska experience entails identification and verification of vegetation types using aerial photography and satellite data. Mr. Scorup has assisted with vegetation inventorying, mapping, and classification of the Susitna River Basin Cooperative Survey and the Seward Peninsula Reindeer Ranges.

Elena B. Sparrow, Postdoctoral Fellow; University of the Philippines '62, B.S. Cornell University '66, M.S.; Colorado State University '73, Ph.D. Dr. Sparrow's research experience is in soil and environmental microbiology and plant-soil relationships. She has worked for the International Rice Research Institute, departments. of Soil Chemistry and Soil Microbiology, Philippines; the Arctic Environmental Research Station, Environmental Protection Agency; and as a consultant on research funded by United States Army Cold Regions Research and Engineering Laboratory, Alaska Projects Office. She was an International Rice Research Institute Scholar to Cornell University in 1964, a Rockefeller Institute travel grantee in 1969, and a postdoctoral fellow at Colorado State University in 1973. She has worked and is currently working with AFES and ARS staff on microbial biomass and decomposition, nutrient cycling, and oil-spill pollution studies.

Stephen D. Sparrow, Jr., Assistant Professor of Agronomy; North Carolina State University '69, B.S.; Colorado State University '73, M.S.; University of Minnesota '81, Ph.D. Dr. Sparrow's research background is in soil microbiology, plant-soil relationships, and soil fertility. He worked for AFES as a research technician from 1973 to 1977, went to Minnesota to attend graduate school in 1977, and returned to Alaska in 1981. Currently he is doing research in the area of nitrogen cycling in Alaskan agricultural soils and on legume-*Rhizobium* relationships in the subarctic.

Roscoe L. Taylor, Professor of Agronomy; South Dakota State University '48, B.S.; Iowa State University '50, M.S. Mr. Taylor has extensive experience in crop breeding and production research in Alaska involving both grain and forage crops. He is responsible for the development of barley, oat, wheat, and rye varieties adapted to Alaska's growing conditions. Mr. Taylor assisted in the development and maintenance of one variety each of bluegrass, fescue, bromegrass, alfalfa, and red clover. His latest research emphasis has been on cereal breeding involving the development of adapted barley varieties possessing urgently needed disease resistance, early-maturing oat varieties suitable for grain and forage, and early-maturing wheat varieties with improved grain yield and quality. Mr. Taylor retired in December 1987.

Keith Van Cleve, Professor of Forestry (Soils); University of Washington '58, B.S.; University of California-Berkeley '60, M.S., '67, Ph.D. Dr. VanCleve has a background in research and teaching in soil-plant relations with research emphasis on the Alaskan taiga. He was formerly associated with USIBP Tundra Biome and taiga forest ecosystems research programs funded by the National Science Foundation. He currently is principal investigator for the Taiga Long-Term Ecological Research Program sponsored by the National Science Foundation. Dr. Van Cleve is in charge of the SALRM Forest Soils Laboratory. His current research interests deal with the structure and function of subarctic forest ecosystems.

Robert B. Weeden, Professor of Resource Management; University of Massachusetts '53, B.S.; University of Maine '55, M.S.; University of British Columbia '59, Ph.D. Dr. Weeden's research interests are in resource policy analysis, particularly in the renewable-resources field. He teaches advanced wildlife management (through a joint appointment with the Department of Biology, Fisheries, and Wildlife), environmental impact analysis and decision making, and natural resources policies and legislation. Dr. Weeden began a twenty six-month term as Head, Department of Biology, Fisheries, and Wildlife in May of 1986.

Paul M. Windschitl, Assistant Professor of Animal Science; South Dakota State University '81, B.S., '83, M.S.; University of Minnesota '87, Ph.D. Graduate work at SDSU involved the use of dried whey in dairy cattle rations and its effect on rumen bacterial metabolism. Graduate work at the University of Minnesota centered around protein and amino acid nutrition of high-producing dairy cows. Of particular concern was the amount of rumen-degradable versus undegradable ("by-pass") protein in the diet. Future work will include the use of fishmeal and urea as protein sources in dairy cattle diets and effects of barley and wheat on rumen fermentation. Also of interest is the use of feed additives (i.e. niacin, yeast) in dairy cattle diets.

Frank J. Wooding, Professor of Agronomy; University of Illinois '63, B.S.; Kansas State University '66, M.S., '70, Ph.D. Dr. Wooding's background is in soil fertility, chemistry, physics, and management; and crop physiology and production. He joined AFES in 1970, where he has studied crop adaptation in the subarctic, cereal grains, oil-seed crops, turfgrass management, revegetation of disturbed land, and the effects of off-road-vehicle use on soils and vegetation. He is currently involved with soil and plant problems associated with development of new lands in the subarctic.

William G. Workman, Associate Professor and Head, Department of Economics, School of Management; University of Wyoming '69, B.S.; Utah State University '72, M.A., '78, Ph.D. Dr. Workman's research background is in natural resources and agricultural economics. His recent work includes valuation and allocation of nonmarket resources, land-use conflicts at the urban fringes, and reindeer-grazing issues on public lands. He teaches courses in economic theory and natural-resources economics and is director of the M.S. program in Resource Economics in the School of Management.

John A. Yarie, Assistant Professor of Silviculture; West Virginia University '71, B.S.; University of Maine '74, M.S.; University of British Columbia '78, Ph.D. Dr. Yarie's research background is in forest nutrient cycling and plant-soil relationships. His current research interests deal with an analysis of the factors influencing forest productivity.

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