1986 ANNUAL REPORT

Agricultural and Forestry Experiment Station

School of Agriculture and Land Resources Management

University of Alaska-Fairbanks

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ANNUAL REPORT

For the year ending December 31, 1986

Fairbanks, Alaska 99775-0080

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June 1987

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, University of Alaska-Fairbanks, for the period ending December 31, 1986. 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, 1987

Contents

Purpose

Research on Alaska's agriculture, forestry, and land resources management is carried out by the Alaska Agricultural and Forestry Experiment Station (AFES), University of Alaska-Fairbanks. The objective of this research 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 resource 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 wise use of land resources.

This report marks 80 years of service for Alaskans by the Fairbanks Research Center of AFES. Moreover, 1987 is the centennial year of the Hatch Act, an act signed into law by President Grover Cleveland on March 2, 1887, to establish and support agricultural experiment stations in each state in conjunction with the land-grant colleges. Each station was to engage in systematic scientific study of problems related to agriculture within the state. In subsequent years Congress extended the Hatch Act to Alaska.

HATCH ACT CENTENNIAL
1887-1987

In 1904, however, the people of Fairbanks asked the U.S. Department of Agriculture to establish an agricultural experiment station in the Tanana Valley. In response, an Executive Order issued on March 22, 1906, provided approximately 1400 acres midway between the towns of Fairbanks and Chena to establish an experiment station. Initially, 10 acres were cleared and planted to crops; by 1918 station cropland had expanded to 100 acres.

Sixteen years later, on December 22, 1922, a plat was filed to establish the Agricultural College and School of Mines, Alaska's land-grant college. The plat included the original 1400 acres allocated to the experiment station plus enough surrounding acreage to make the total holdings total ap-

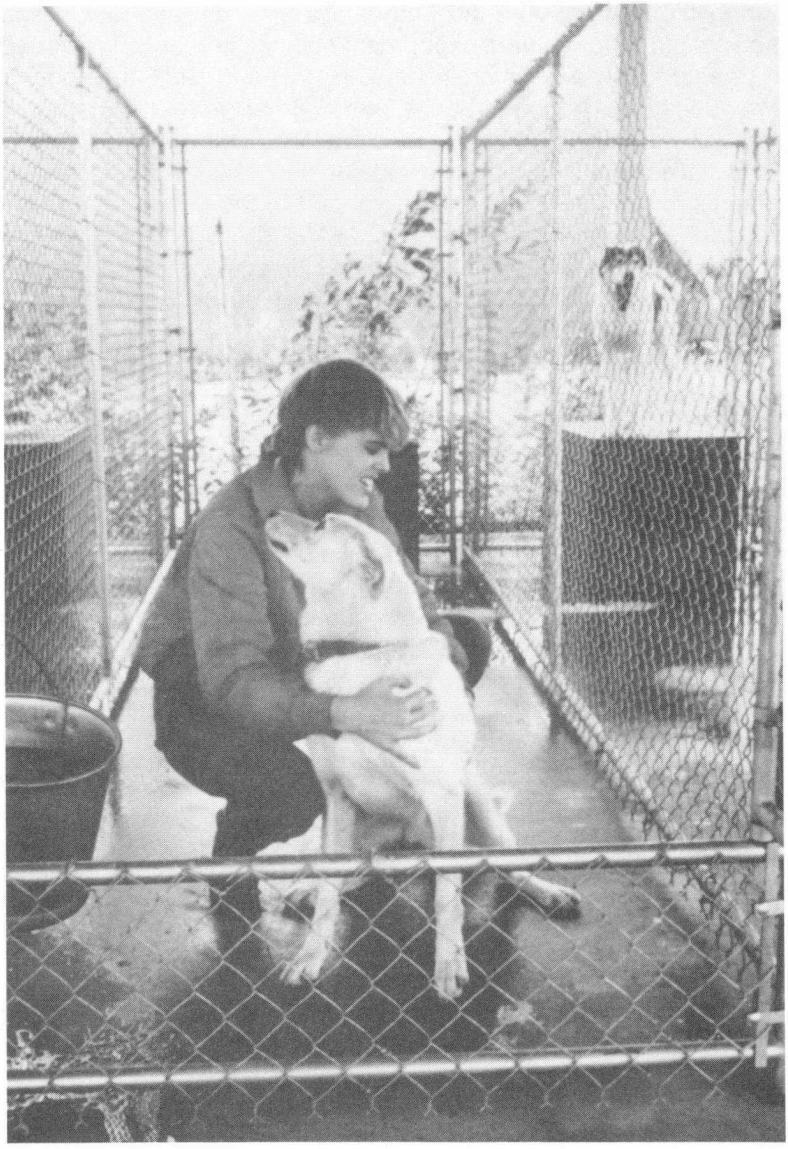
proximately 2300 acres. In 1935, the Agricultural College and School of Mines became the University of Alaska.

During the early 1900s, the Federal government also established a number of other agricultural experiment stations in Alaska including one near Palmer that was initiated in 1915. In 1931 and 1932, the Federal experiment stations near Fairbanks and Palmer were transferred from Federal ownership to Alaska's land-grant college. Today these early Federal stations are the Fairbanks and Palmer Research Centers of AFES.

Administratively, AFES is an integral part of the School of Agriculture and Land Resoruces 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.

Research completed at AFES is published in scientific journals as well as in experiment station 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 greenhouse operations to potato production, from reindeer herding to forest productivity, and from minespoil reclamation to the management of outdoor recreation. Through these programs, as well as through advisory committees, feedback is obtained by experiment station scientists about problems that need research attention.

This annual report is divided into three major sections: plant and animal science, forest science, and resource management. Each section provides summaries of research projects underway at AFES. The report concludes with a list of all publications for 1986, a presentation of the faculty and professional staff for SALRM, and a financial statement.



Plant and animal science studies at the Agricultural and Forestry Experiment Station address many concerns unique to Alaska. As the result of one such study, sled dog diets which include greater than 50 percent Alaskan 'Thual' barley and herring meal have been developed through cooperative research. (photo by Ken Ulz)

Plant and Animal Sciences

Cereal Breeding and Production

The major cereal-breeding activity during 1986 was the selection of several thousand barley lines which exhibit field resistance to barley scald and other diseases and which also possess at least marginal adaption to the production environments of Alaska. About 300 lines provided sufficient seed for more precise determination of agronomic performance and disease reaction in 1987. Materials of this nature are being combined with the best-adapted, early-maturing, high-yielding strains to develop segregating populations which will be subjected to natural selection in the areas of present and potential barley production in the state. Barley-breeding progress is being accelerated through the use of a winter field nursery in Arizona. Use of this facility will permit the production of many more crosses than can be handled in the limited indoor space of current winter growth facilities in Alaska. Oat- and wheat-breeding efforts were limited to further defining agronomic qualities of potential breeding materials.

Detailed agronomic evaluations were conducted on a limited number of varieties and advanced selections of barley, oats, and wheat at Palmer in 1986. The extended dry period from time of planting through June resulted in near-record low grain and forage yields for the season. Several new selections continued to demonstrate excellent relative performance, especially for oat forage yields. Alaska oat lines compare favorably with Canadian varieties which are, in general, superior in performance to varieties commonly available from the Pacific Northwest.

Limited quantities of seed of most released varieties remain available. Seed of one each of new, improved selections of barley, oats, and wheat are available for increase and release to seed producers. *R.L. Taylor.*

Cereal Crop Germ Plasm: International Exchange

Letter contacts with several leading cereal development organizations in Norway, Sweden, and Finland provided 44 barley, 32 oat, and 7 wheat breeding lines for evaluation in Alaska. Circumstances prevented extensive performance testing in 1986, although the barley selections were planted at Palmer in observational increase plots. This material is scheduled for trials at Palmer and Delta in 1987. In exchange for these lines, four each advanced breeding strains of barley, wheat, and oats from Alaska were supplied to five breeding programs in Norway, Sweden, and Finland. Contacts made during this exchange should foster future cooperative efforts with these countries. *R. L. Taylor.*

Plant Germ Plasm Introduction, Increase, Evaluation, Documentation, Maintenance, and Distribution

Grain variety trials are conducted on an annual basis so that new varieties developed in other northern agricultural regions can be evaluated to determine their adaptability to Alaska's growing conditions. These trials are the basis for making variety recommendations to interior Alaska farmers. During 1986, 20 barley, 11 oat, and 13 wheat varieties and experimental lines were evaluated in replicated standard trials at Fairbanks and Delta Junction. The Delta Junction site was situated on recently cleared forest land which had been summer fallowed the previous year. The Fairbanks site was situated on fall-tilled oat stubble land which had been in production for 57 years. Both test sites were drier than normal during May and June. This resulted in grain yields that were somewhat lower than the long-term averages.

The varieties and experimental lines for each grain type were separated into two maturity classes: *very early to early,* and *medium to late.* At Fairbanks, the highest yields in each of these crops for the very-early-to-early maturity class were as follows: 'H349-348 (ACA2566)' barley, 57 bushels per acre; 'Jasper' oats, 99 bushels per acre; and 'MS273-150 (ACA2571)' wheat, 50 bushels per acre. The highest yields for each of the crops for the medium-to-late maturity class were as follows: 'Hankkija's Pokko' barley, 53 bushels per acre; 'Calibre' oats, 121 bushels per acre; and 'Tapio' wheat, 50 bushels per acre. At Delta Junction, the highest yields in each of the crops for the very-early-to-early maturity class were as follows: 'Hankkija's Eero' barley, 90 bushels per acre; 'Pol' oats, 106 bushels per acre; and 'Ingal' wheat, 46 bushels per acre. The highest yields in each of the crops for the medium-to-late maturity class were as follows: 'Heartland' barley, 91 bushels per acre; 'OT 745' oats, 102 bushels per acre; and 'MS57-8 (ACA2569)' wheat, 50 bushels per acre.

'Hankkija's Eero', 'Hankkija's Pokko', and 'Jo 1184' are three barley varieties that have performed well in interior Alaska trials conducted over a 5-year period. In 1986, foundation seed for these barleys was purchased from Finland, and initial seed increases were successfully grown at two Alaska locations. In 1987, registered seed of these varieties will be distributed to a select group of Alaska farmers for the production of certified seed. *F.J. Wooding.*

Low-Temperature Physiology of Crop Plants

Winter rye plants were grown at 68 and 40 degrees Fahrenheit in growth chambers with either 8- or 16-hour photoperiods. Shoot growth was measured as a function of time as dry weight, number of tillers and leaves, and leaf area in order to understand the interaction of temperature and photoperiod on plant growth. The ability of the leaves to tolerate freezing was also determined by electrical conductivity. Plants grown at 40 degrees for 16 hours accumulate dry weight at 60 percent of the rate of the plants grown at 68 degrees for 16 hours. The plants grown at 40 degrees for 16 hours exhibit little height, leaf, or tiller growth as the leaves rapidly accumulate dry matter. Freezing injury is observed in these leaves below minus 8 degrees. Plants grown at 40 degrees for 8 hours accumulate dry

weight at 44 percent the rate of plants grown at 68 degrees for 16 hours. Although there was some accumulation of dry matter in the leaves, the plants do exhibit growth in leaves, tillers, and plant height. The leaves are frost hardy to temperatures lower than minus 22 degrees. Leaves of plants grown at 40 degrees for both 16 and 8 hours are most resistant to freezing when the water content of the leaves has dropped to 70 percent. Although rye leaves grown at 40 degrees for 16 hours or for 8 hours are both adapted to low temperature, the two sets of leaves vary by more than 14 degrees in their frost hardiness. These two sets of leaves may therefore provide a model system in which the factors important in plant growth at low temperature can be separated from the factors important in the development of freezing resistance. *M. Griffith.*

Low-Temperature Development of Photosynthetic Membranes

The effect of low temperature upon the development of photosynthetic membranes was studied in 'Puma' rye. Photosynthetic electron transport activity was measured weekly for individual leaves in winter rye plants grown at 68 degrees Fahrenheit and biweekly in plants grown at 40 degrees. Photosystem I (PSI) activity was measured using ascorbate and dichlorophenolindophenol (DCPIP) as electron donors and methyl viologen as an electron acceptor, expressed in micromoles of oxygen consumed per milligram of chlorophyll (Chl) per hour, whereas photosystem II activity (PSII) was measured using water as the electron donor and DCPIP as the electron acceptor, expressed in micromoles of DCPIP reduced as milligrams of Chl per hour. PSI rates were 25 to 55 percent higher in leaves shifted to or developed at 40 degrees. PSI activity in leaves maintained at 68 degrees declined with age at a rate 2.3 times faster than PSI rates in leaves shifted to 40 degrees. However, PSII activity was always lower in leaves shifted to or developed at 40 degrees. PSII activity in 68 degree leaves decreased 3.5 times faster with age than PSII rates in 40 degree leaves. In addition, PSII activity increased at much slower rates in new leaves developed entirely at low temperature. These results indicate that rates of electron flow through PSII are slowed at low temperature, due in part to the slower development of PSII electron transport capacity in these leaves. The development of PSI activity is much less affected by

temperature, and so PSI activity is actually increased at the lower temperature. *M. Griffith.*

Snow Mold Disease Control

Since 1980, many attempts have been made to control snow mold disease by using fungicides. Through the years, fungicides such as benomyl, baytan, bayleton, dithane M-45, rovral, and terraclor have been tested for their effectiveness in controlling snow mold disease. Among all the fungicides tested, terraclor was found effective in controlling the disease both in laboratory tests and in field trials. The other fungicides were found capable of inhibiting the growth and development of snow mold fungi under laboratory conditions, but were found ineffective in controlling snow mold in the field. While terraclor has showed great promise in terms of cost-effective analyses, it is only marginally economically feasible in farm operations.

In 1985, isolation of natural antagonists of snow mold fungi from the Alaskan environment was initiated. A low temperature tolerant fungus displaying a remarkable ability not only in controlling the growth and development of snow molds but also many other pathogenic fungi has been isolated. Currently, efficacies of this isolate in controlling snow mold disease under field conditions are being tested. *J.H. McBeath.*

Snow Molds and Their Extracellular Enzymes

Snow mold disease is the single most important problem of winter cereals in Alaska. It affects the winter survival of rye and wheat, and it seriously hinders the state's agricultural development.

Several psychrophilic fungi have been found capable of causing snow mold disease in Alaska. Among them, *Sclerotinia borealis* and a sclerotial low temperature basidiomycete (SLTB) are most prevalent. *Fusarium*

nivale, a newly found causal agent of snow mold disease in Alaska, is also common.

Snow mold fungi infect host plants in late fall. The disease develops on plants through the winter when they are blanketed with a thick layer of snow. Observations made of snow mold-diseased plants in the field and in the laboratory in past years strongly suggest a direct correlation between snow mold extracellular enzyme production and symptom expression, as well as development of the disease. For instance, a wheat plant diseased by snow mold *S. borealis* can be differentiated readily from other snow mold-diseased plants by the extensive tissue maceration on leaf-blades and sheaths which frequently results in massive diffusion of chlorophyll onto the snow causing a 'green snow' effect.

In collaboration with Dr. L. Wenko at the Plant Molecular Genetics Laboratory, USDA-ARS, Beltsville Agricultural Research Center, a method was developed in 1986 to detect the extracellular cellulytic and pecteolytic enzyme activities of snow mold fungi. *S. borealis, F. nivale,* and SLTB were cultured on a mineral salts liquid medium containing wheat straw. Culture filtrates were harvested and concentrated by ultra-filtration. Minute samples of the concentrated culture filtrates were resolved with gradient nondenaturing polyacrylamide gel electrophoresis. Cellulytic enzymes assayed with a cellulose-agarose overlay stained with Congo red and pecteolytic enzymes were assayed with a pectin-agarose overlay stained with ruthenium red. By sandwiching a gel between two overlays and then staining with respective dyes, cellulytic and pecteolytic enzymes were detected in a single preparation. Cellulytic enzyme activity was detected in SLTB. Pecteolytic and cellulytic enzyme activities were noted in *S. borealis. F. nivale* also produced cellulytic enzymes with molecular weights larger than those detected in *S. borealis* and SLTB.

The combination of bioautography and nondenaturing polyacrylamide gel electrophoresis provided a method for the detection of snow mold extracellular enzyme activities. This method is simple to use, easy to set up, fast in producing results, sensitive in detecting minute amounts of enzymes, economical in cost, and extremely versatile. *J.H. McBeath.*

Anther Culture of Winter Wheat

Growing winter crops in Alaska provides great advantages for farm management, water and soil conservation, and pest management. Due to the environmental conditions, winter cereals grown in Alaska must possess cold-hardy, early-maturing, and snow mold disease resistance characteristics. Several hard red winter wheat cultivars have proved capable of sustaining winter harshness, but, of more than 38 germplasms tested that were reputed to be resistant to snow molds *Fusarium nivale* and *Typhula spp.,* none has been found resistant to the snow molds *Sclerotinia borealis* and sclerotinal low temperature basidiomycetes found in Alaska.

Breeding plants through traditional methods such as pedigree and backcross methods is very time consuming, labor intensive, and costly. It usually requires many generations to obtain pure lines from a heterozygous source. Androgenic haploid plants, obtained through such in vitro techniques as anther culture or anther-panicle culture, have proven to be useful in plant breeding practice. Cell culture techniques provide a means for the recognition and recovery of genotypes that are difficult to manipulate in field populations. Selection at the haploid level permits the rapid recovery of recessive alleles, e.g., disease resistance, temperature sensitivity, and salt tolerance. Coupling the haploid and double haploid techniques with a conventional breeding program has resulted in rapid development of new cultivars. With barley, for instance, the time for releasing a new cultivar has been reported to be five years instead of twelve by using this new technique.

In 1986, in collaboration with Dr. G. Schaeffer at the Plant Molecular Genetics Laboratory, USDA-ARS, Beltsville Agricultural Research Center, attempts were made to develop anther culture and related in vitro techniques for cold-hardy, early-maturing, hard red winter wheat. The long-range goal is to provide a means by which tolerance to snow mold in winter wheat cultivars can be expanded.

Anthers of the cultivars 'Capitan,' 'Froid,' 'Nostar,' and 'Roughrider' at the uninucleate stage of pollen (microspore) development were excised after cold shock treatment. Anthers were cultured on boiled potato extract media. Embryoids produced from the microspores were transferred to an increase medium containing Murashige-Skoog basal salts, 2, 4-D, and NAA for callus proliferation. Large calli were later transferred to a step-down medium without 2, 4-D and NAA, but containing IAA and kinetin, to pro-

mote the differentiation of roots and shoots. Embryoids and small microspore calli have been observed from all three cultivars. Green plantlets were obtained from the cultivars Capitan and Roughrider.

This technique provides a powerful tool in selecting and manipulating winter wheat genetic materials for snow mold resistance. The system is not only more precise but also more efficient and economical than traditional methods. *J.H. McBeath.*

Cyanogenesis of Sclerotial Low Temperature Basidiomycete

The sclerotia-forming low temperature basidiomycete was first observed on sheaths of winter wheat killed by snow mold disease in the spring 1981. Since then, sclerotial low temperature basidiomycete (SLTB) has been consistently isolated from the sheath and crown of many snow mold-diseased plants. Observation made on the growth and development of this fungus indicated that SLTB grew well at low temperatures, with an optimum temperature between 39 and 50 degrees Fahrenheit. SLTB appeared to perpetuate itself vegetatively with mycelia and sclerotia served as propagules. Attempts made to induce the fruiting body formation from sclerotia have not been successful.

In 1986, the cyanogenesis studies of SLTB were initiated. The consistent negative results obtained from these studies indicated that unlike LTB, the SLTB did not produce HCN and was not cyanogenic by nature.

Light and scanning electron microscopic studies of roots and shoots of winter wheat at different stages of SLTB snow mold-disease development revealed that extracellular enzymes produced by the SLTB might contribute to the death of plant tissues.

The sclerotia-forming and noncyanogenic characteristics of the SLTB provided important information for the breeding of snow mold resistance. Differences between SLTB and LTB indicated that these two snow mold fungi are probably different taxonomically. *J.H. McBeath.*

Seed Transmission of Bacterial Mosaic of Wheat

Bacterial mosaic disease was first diagnosed in Alaska on spring wheat and triticale in 1980. The diseased plants display 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* (Alaskan strain), was found to be the causal agent of this disease.

This disease has been found to be transmitted mainly through contaminated seeds. Surveys conducted on spring wheat seed lots showed an extremely high percentage of the seeds tested were contaminated with this bacterium. In 1986, experiments conducted on seed treatments indicated that except for streptomycin and several antibiotics, methods such as hot water treatment, chlorox with or without tween 80 additive, and Alcide chemical treatment were either ineffective in the elimination of this bacterium from the contaminated seeds or caused serious impairment of the viability of the seeds, resulting in a drastic reduction of germination.

Scanning electron microscopy (SEM) of the seeds revealed the presence of clusters of bacteria in the seed coat-endosperm interface near the embryo. The fact that the bacteria were found under the seed coat rather than merely on the surface indicated that these bacteria were well protected, which explained why many of the seed treatments were ineffective in eliminating these bacteria from contaminated seeds.

C. michiganese ssp. *tessellarius* may be a latent endophyte. It has been consistently detected from root, sheath, and leaf tissues of seedlings and plants germinated from the contaminated seeds well before these plants show any symptoms. Results from SEM studies of the host tissues showed that the bacterium exists mostly in the sieve elements. Its low populations in the cells may contribute to the delayed symptom expression.

The distribution of this disease is not know. Our findings indicate that this little-studied disease might be much more widespread and economically important than is thus far generally perceived. *J.H.McBeath.*

Cultural Practices for Rapeseed in Alaska

The success of spring rapeseed production in interior Alaska depends upon the crop's ripening to a harvest stage prior to heavy snowfall in the autumn. To ensure early, uniform ripening, the seed must be placed in moist soil at a shallow depth (.5 to 1 inch) early in the spring. The objective of this study is to determine whether spring rapeseed can be produced successfully from seed planted in late autumn or early spring when the soil is cold or frozen. Under ideal circumstances, this early-planted seed germinates as soon as the surface inch of soil is warm enough, thus giving it an earlier start than rapeseed planted early to mid-May. It should also allow the young plants to make maximum use of spring meltwater. Also, this technique would widen the time window of planting, which is extremely narrow in interior Alaska.

Two rapeseed cultivars, 'Candle' and 'Tobin', are each planted at weekly intervals from late September until the snow depth exceeds 6 inches. Weekly plantings are resumed in the spring as snow is leaving the fields and are continued through the first week of May. Plant population counts are made during the seedling stage, and maturity notes are taken throughout the growing season.

The results from the first two field seasons showed that plant populations and seed yields from spring plantings greatly exceeded those from autumn plantings. No particular time of planting in the spring was found to be superior overall to any other spring planting date, although the very early plantings sometimes did not do as well as the later plantings. Rainfall patterns seemed to have a greater effect on crop maturity than did planting date. In 1985, we tested the effects of no-tillage planting into protective crop residues as a possible means of improving plant survival from autumn and early-spring plantings. However, for all planting dates, no-till plantings were greatly inferior to bare-ground plantings, both in terms of plant stand and seed yields. Also, the fall seedings again produced poorer stands and lower yields than did the spring plantings. In 1986, the entire crop was destroyed by flea beetles. The study is continuing with additional tests designed to help determine why fall-planted seed does not survive well. *C.W. Knight and S.D. Sparrow.*

Conservation Tillage and Residue Management Research

The soils of Alaska's interior, the major area used in small-grain production, are silt-loam and 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. Research concerning the use of conservation tillage is site specific and must be adapted to regional conditions. At the conclusion of our conservation tillage research in 1982, it was evident that reduced tillage would control soil erosion but additional problems to be addressed were:

- a short growing season,
- cool soils,
- marginal soil-water availability early in the growing season,
- low fertility in newly cleared soils,
- 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 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, and disk in the spring and fall. Two types of planters are 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 on the seed bed. A disker seeder which operates similar to a disk is used only on the no-tillage and chiseled plots. The parameters measured (other than grain yield and quality) are soil and air temperatures, wind speed, relative humidity, solar budget, soil moisture, soil fertility, surface crop residues, and soil aggregation. Snow-depth measurements are taken throughout the winter, and rainfall is measured during the year. Germination counts and plant dry matter at five stages of growth are also recorded.

Tillage and residue management techniques affect soil temperatures early in the season just prior to tillage and seeding in mid- to late May. The no-tillage plots are thawed to a depth of six inches while the tilled plots are still frozen at the surface. The tilled plots do not retain snow through the winter, and the surface is extremely cloddy and dries leaving a dust mulch. There is apparently not a sufficient transfer of heat through the dust mulch and rough clods to allow soils to thaw in the spring. During the growing season, tillage and residue effects are mitigated.

Temperatures remain below 50 degrees Fahrenheit until mid-June at the seeding depth of 2 inches. This is also the period during which there is low surface-soil moisture availability. Crop development is slow. After mid-June and to heading in mid-July, soils warm to near 60 degrees Fahrenheit in the rooting zone 2 to 10 inches. This is also a period in which more moisture is available and crop development is rapid.

Analysis of variance showed that tillage and the interaction of tillage and seeders significantly affected yields at the .01 level for the combined years 1984, 1985, and 1986. Highest yields for these years were obtained when the chisel treatment was used in combination with the double-disk, press-wheel drill (2506 pounds per acre). No-till treatments with all seeders yielded lowest with an average of 1610 pounds per acre. The tillage-seeder interaction is most likely caused by the opposing performance of the hoe and double-disk seeders and is evident in the reduced tillage treatments. Depth control of the hoe drill is erratic in loose soils and on a rough seed bed. It performed poorly, particularly in plots which were disked twice and plots which were chiseled. The average yields obtained were 2105 pounds per acre. The double-disk seeder performs very well under these conditions and its use resulted in the highest yields obtained in the three-year period (2456 pounds per acre).

The effect of seeders was also evident in grain quality. Use of the hoe drill resulted in seeding at depths greater than the desired 2 inches and thus in uneven maturation. Grain was high in moisture, ranging from 20 to 29 percent. This resulted in kernal shrinkage when the grain was dried, thus affecting quality adversely.

The major problem encountered in the use of no-tillage and, to some extent, reduced tillage has been the persistence of perennial grassy weeds. Chemical control has been ineffective. The tilling action of the hoe and disker seeder accounts for some control, but at the close of the 1986 season, yields on no-tilled plots on which these seeders were used were near zero. In 1986, the no-tillage, double-disk seeder plots were fallowed using both chemical and mechanical techniques. The results of these treatments are as yet inconclusive. Also, in 1986, grassy weeds were more prevalent in the reduced-tillage plots than they had been in previous years. *C.E. Lewis, R.F. Cullum, and B.J. Pierson.*

Fertilizer Placement in Reduced Tillage Systems

Fertilizer efficiency as a result of placement may vary due to changes in moisture and soil temperature under different crop residue and tillage management in reduced tillage systems. Two studies were designed, one to evaluate the performance of phosphorus (P), another to evaluate the performance of nitrogen (N) in a continuous rotation of barley. The management system used in each study was a single disking in the spring. All loose straw from the previous crop was removed allowing only standing stubble to remain through the winter.

The first study addressed the effect of P application, method of application, and the residual effect of P on barley yield. The treatments consisted of two types of seeders: a double-disk, press-wheel drill to obtain a banding effect and a disker seeder to obtain a broadcast effect. Levels of P applied with the seed were 0, 9, 18, 36, and 72 pounds per acre. In 1984 and 1985, 0 and 9 pounds P per acre were applied at the time of seeding across treatments established in 1983 using the double-disk, press-wheel drill. Yields in the first year of the study exceeded those in following years at all rates above the zero-P application. There were significant differences in yield in 1983 between the banded and broadcast treatments with the broadcast treatment the highest. No significant differences in yield were obtained in P treatments above 9 pounds per acre for the banded treatment and 18 pounds per acre for the broadcast treatment. Significant yields ranged from 2579 to 3320 pounds per acre. Soil-P levels after the first growing season were significantly higher in soils that received higher rates of P-fertilizer, however, these higher levels did not contribute to significantly higher yields. An annual application of 9 pounds P per acre was not sufficient to maintain soil P levels after initial high fertilizer application rates. Results from the three-year study indicate that, in reduced tillage systems, crop response to P is affected by placement of fertilizer. Root development and exploration in a larger volume of soil may be enhanced by placing P in a broader band.

The second study considers the effect of placing the total applied nutrient requirement in a band with the seed. The 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_2O_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 both 1985 and 1986, yields increased significantly as a higher percentage of fertilizer was banded with the seed. In 1985, 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 1986, type of fertilizer did not significantly affect yields. *C. E. Lewis and B. J. Pierson.*

Effects of Tillage and Straw Management On Soil Microbial Activity

Measurements of soil enzyme activity and microbial biomass made on soil samples collected from a 3-year study having till and no-tillage treatments with or without all crop residue removed failed to detect differences in microbial activity. However, nitrogen (N) mineralization studies indicate that leaving all crop residue on the soil surface of no-till barley increases the soil's potential for mineralizing N compared with incorporation or removal of crop residues. This is likely due to an increase in readily decomposable material near the soil surface. Litter bag studies confirm that surface crop residues are decomposing at a much slower rate than incorporated straw. Approximately 30 percent of the incorporated straw decomposed during the summer while only 10 percent of the surface straw was lost. Even with 30 percent of the straw decomposing during the summer, continued additions of crop residues may increase soil organic matter. However, that remaining will continue to decompose as new material is returned after the next crop and no large increase in organic matter is expected.

N mineralization studies of forest soil near Delta Junction showed that the Oie horizon (moss layer) has the potential to mineralize substantial amounts of N when kept warm and moist for 8 or more weeks. This layer

is usually removed during clearing, but appears to be a valuable component of the soil which needs further study. *V.L. Cochran and S.D. Sparrow.*

Weed Control Research

After two years of burial in a 50-year seed longevity study, it appears that weed species differ dramatically in the length of time that seed remains viable in the soil. Seed of foxtail barley, common hempnettle, and quackgrass were mostly nonviable after two years of burial. In contrast, seed viability of shepherdspurse and pineappleweed did not decrease significantly after two years of burial in the soil.

A study was performed to determine the optimum timing of glyphosate applications to control bluejoint reedgrass. Glyphosate was applied every two weeks to different plots throughout the growing season. Applications made before June 1 or after August 1 were not effective in controlling bluejoint reedgrass. Rates as low as 1 pint per acre (Roundup) were effective when applied between June 7 and July 15. *J.S. Conn.*

Potato Variety Trials

Replicated yield trials with 44 varieties of potatoes were conducted under irrigated and nonirrigated conditions. Overall yields were averaged in comparison to yields of the past four years. Rainfall during the growing season exceeded 10 inches, more rain than has fallen at the Matanuska Farm at Palmer in any of the last five years. However, rainfall in May and June was deficient, causing moisture stress in nonirrigated plots. Air and soil temperatures for the 1986 growing season were average to slightly above average.

In the nonirrigated trial, 'Green Mountain' achieved the top US #1 yield of 15.5 tons per acre, followed by 'Acadia Russet' and selection 3-79-280-81. 'Sangre', a red-skinned variety popular in Colorado, also did well in the nonirrigated trial. 'Kennebec' yielded best in the irrigated trials

(16.9 tons per acre US #1), followed by 'Caribe' and selection 6-78-139-80. Caribe, a white-skinned variety developed in Canada, may have commercial potential here. 'Russette', 'Centennial Russet', 'Bintje', 'Jemseg', and 'Nemarus' yielded poorly in irrigated and nonirrigated trials.

Replicated yield trials, made possible by the cooperative efforts of several agencies and private citizens, were conducted at seven locations throughout the state. Best yields were recorded at sites near Fairbanks, Delta Junction, and Kake, with Kodiak Ambler, Noorvik, and Copper Center sites yielding less. (Circular #58, "Potato Variety Performance-Alaska 1986" contains details of all yield trials mentioned above.) *D.E. Carling.*

Evaluation of Isolates of *Rhizoctonia Solani* Recovered From Potato Plants and Potato Field Soil

Isolates of *Rhizoctonia solani* were recovered from twenty potato plants (subterranean stem lesions, tuber-borne sclerotia, hymenia on aerial stems) and associated field soil (beet seed, KHP) at three locations near Palmer, Alaska. Isolates were grouped according to their anastomosing characteristics and will be grouped according to pathogenicity, in vitro colonial characteristics, and clonal behavior.

Seventy-eight percent of the isolates were members of anastomosis group-3 (AG-3), the type causing rhizoctonia disease of potato. The remaining isolates were either AG-2-1 or AG-9, neither of which damage potatoes to any any significant degree. We will attempt to relate in vitro colonial morphology, pathogenicity, and anastomosis group in the next phase of this work. *D.E. Carling.*

Effect of Seed-Borne Inoculum of *Rhizoctonia Solani* On Potato Growth and Yield

A field plot free of *Rhizoctonia solani* AG-3 was selected as a site to test the effects, including yield-reducing potential, of seed-borne inoculum

of *R. solani.* Ten weeks after planting, 23.9 percent of the contaminated seed pieces had not emerged, compared to 1.0 percent of the noncontaminated seed. By 14 weeks after planting, all but 6.5 percent of the contaminated seed had emerged, but the delayed emergence no doubt resulted in yield reductions. Nearly 87 percent of plants produced by contaminated seed bore large necrotic lesions on subterranean stems, compared to lesions on 6.7 percent of plants produced from noncontaminated seed. Aerial stem lesions, aerial tubers, and mycelia were 3 to 40 times more common on plants from contaminated seed. Contaminated seed resulted in yield reductions of 33.3 percent in 'Alaska 114', 74.7 percent in 'Bakeking', 61.3 percent in 'Kennebec', and 40.7 percent in 'Superior'. Dipping seed for two minutes in 1.85 percent formaldehyde greatly reduces seed-borne inoculum of *R. solani,* and therefore reduces the effect of the fungus on yield. *D.E. Carling.*

Commercial Vegetable Production

Commercially produced broccoli must meet rigorous size and quality standards and must yield well enough to be grown on small acreages. 'Shogun' and 'Green Valiant', two varieties which had yielded well in observation trials in Fairbanks, were grown using rows spaced at 3-foot intervals and plants spaced at 12-, 16-, and 20-inch intervals within each row. The optimal spacing for yield and head size was 3 feet by 1 foot. Green Valiant yielded 13,900 pounds per acre in 1985 and 14,000 pounds per acre in 1986. Eighty-seven percent of this yield met U.S. No. 1 standards. The heads averaged 6 inches long and 6.2 inches wide, weighed 1 pound, and were harvested 56 days from planting. Shogun yielded 19,800 pounds per acre in 1985 and 45,600 pounds per acre in 1986, however 61 percent of the crop did not meet U.S. No. 1 standards, and 32 percent of the crop exhibited hollow stem. The heads averaged 11.7 inches long and 9.5 inches wide, weighed 1.5 pounds in 1985 and 3.4 pounds in 1986, and were harvested 77 days from planting. Shogun is not recommended for commercial planting because of the large size and poor quality of the head, the large year-to-year variation in yield, and the length of produc-

tion time. Green Valiant has yielded consistent, high-quality crops, and is recommended for such production. *M. Griffith.*

Interaction between *Rhizoctonia Solani* AG-2-1 and *Delia Floralis* on Cauliflower

In the field, inoculation of soil with *Rhizoctonia solani* AG-2-1 resulted in destruction of seeded cauliflower stands, regardless of treatment with terrachlor (PCNB). Therefore, high introduced populations of pathogenic isolates of *R. solani* AG-2-1 are not measurably affected by recommended rates of PCNB. Plots inoculated with *R. solani* AG-2-1 yielded from 0.0 to 11.1 percent of noninoculated plots. In inoculated plots treated with both PCNB and Lorsban (chloropyrofos), 2.9 percent of seeds emerged, compared to 0.5 percent emergence with either PCNB or chloropyrofos treatments. Seedling emergence in noninoculated plots ranged from 76-81 percent, indicating indigenous populations of *R. solani* AG-2-1 were either low or comparatively less pathogenic. Indigenous populations of *Delia floralis* were not high enough to permit meaningful evaluation of interactions between *R. solani* and *D. floralis. D.E. Carling.*

Cultural Practices for Field-Grown Lettuce

Studies with 'Salinas' lettuce again demonstrated that harvest can be advanced 14 to 20 days by transplanting instead of direct seeding. In addition, per-acre yields of transplanted lettuce tend to be higher than yields of seeded lettuce, and it remains to be seen if transplanting is an economically feasible practice for growers to consider.

Lettuce transplants produced for growers by a commercial company in California were compared with transplants produced by a local greenhouse. In terms of in field survival, yield, and transplant to harvest interval, no difference was detected.

A fertilization study indicates 100 to 125 pounds per acre nitrogen (N) applied as (NH_4) NO_3 maximizes yields of seeded and transplanted lettuce. Additional N, up to 250 pounds per acre resulted in no increase in yield. Late-season sampling indicated the majority of residual N was located between 6 and 12 inches deep in the soil. This study will be repeated in 1987. *D.E. Carling.*

Comparison of Commercial Vegetable Production In the Tanana Valley and the Matanuska-Susitna Valley

Variety selection is important for all carrot producers in order to obtain optimal yields of high-quality carrots able to withstand the rigors of mechanical harvesting and washing. In 1986, replicated trials of four carrot varieties were conducted in Fairbanks and Palmer. Carrots were planted at a density of 18 to 20 carrots per foot, and yields were calculated as the production of U.S. No. 1 and U.S. No. 1 Jumbo carrots. In Fairbanks, yields were ranked as follows: 'Super Nantes', 21.6 tons per acre; 'Scarlet Nantes', 19.7 tons per acre; 'Pioneer', 19.3 tons per acre; 'Gold Pak', 17.6 tons per acre. In Palmer, carrot yields were: Pioneer, 20.6 tons per acre; Gold Pak, 18.3 tons per acre; Scarlet Nantes, 15.2 tons per acre; and Super Nantes, 10.9 tons per acre.

Broccoli is a crop with commercial potential in Alaska, however it is essential that the head size be appropriate for marketing. A spacing trial of the two broccoli varieties 'Green Valiant' and 'Emperor' was conducted at Fairbanks and at Palmer to determine the spacing required for optimizing both yields and head sizes. In this factorial experiment, broccoli seedlings were planted at 36- and 18-inch row spacings, at 12 and 16 inches within row spacings, and at one or two plants per transplant plug. At the optimal spacing of 18 inches between rows, 16 inches within rows, and one plant per transplant plug, Green Valiant yielded 8.3 tons per acre in Fairbanks and 8.3 tons per acre in Palmer. The heads averaged 4.3 inches wide, 7.7 inches long, and weighed 9 ounces. Although 100 percent of the crop was graded at U.S. No. 1, 22 percent of the heads exhibited hollow stem. The harvest period was 6 days long. At the same spacing, Emperor yielded 6.3 tons per acre in Fairbanks and 7.1 tons per acre in Palmer. The heads averaged 3.7 inches wide, 7.3 inches long, and

weighed 7 ounces. Ninety-six percent of the crop was graded U.S. No. 1. Emperor was harvested 7 days earlier than Green Valiant, and the harvest period was 5 days long. Higher yields were obtained at closer spacings, but the harvest period was prolonged and the average head size and quality were reduced. *M. Griffith and D.E. Carling.*

Vegetable Variety Selection and Cultural Practices For the Home Gardener

The production of such root crops as radishes and turnips has been limited in Alaska by root maggots which scar the surface and produce tunnels in the roots. The recommended practice for control of root maggots involves application of diazinon in the row before planting. With the introduction of floating row covers made of spunbonded polyester, it may be possible to reduce maggot damage to root crops by using row covers to provide a physical barrier to the adult flies attempting to lay eggs. A radish crop seeded on May 30, 1986, exhibited no maggot damage in control or diazinon-treated plots, presumably because the harvest occurred before larvae emerged. In the crop which was seeded on July 1, 1986, only 9 to 15 percent of the radishes in control or diazinon-treated plots exhibited root maggot damage. Radishes grown under a floating row cover of Reemay were more likely to be undersized or affected by such other problems as Rhizoctonia. Thus the use of row covers did not improve radish production. In a turnip crop seeded on May 30, 1986, 83 percent of the roots on control plots and 93 percent of the roots on diazinon-treated plots exhibited maggot damage. Seventy-four percent of the turnips grown under Reemay met U.S. Grade A standards, while another 20 percent were undersized. In a turnip crop planted on June 30, 1986, 90 percent of the turnips in both control and diazinon-treated plots were damaged by maggots. Although 17 percent of the turnips grown under Reemay also had maggot damage, 72 percent of the roots met U.S. Grade A standards. The use of floating row covers dramatically reduced maggot damage and resulted in a substantial improvement in the harvest of high-quality turnips. Because of the increase in undersized roots, lighter row covers which transmit more sunlight will be tested in order to develop specific recommendations for their use.

Successful tomato production in the home garden is dependent upon selection of an appropriate variety. In 1986, we examined the yields of eight tomato varieties ('Alaska Sterling', 'Alpha', 'NDS 18', 'NDS 39', 'Siberia', 'Subarctic 25', 'Superarctic F1', and 'Superarctic F2') grown with and without plastic mulch. The use of clear plastic mulch resulted in higher yields of ripe tomatoes, increased size of ripe tomatoes, and higher yields of green tomatoes for all varieties. The highest yielding varieties grown with plastic were Subarctic 25, 3.8 pounds of ripe tomatoes per plant; Superarctic F1, 3.4 pounds per plant; and Alaska Sterling, 3.2 pounds per plant. The highest-yielding tomatoes grown without mulch were Subarctic 25, 2.8 pounds per plant; Superarctic F1, 2.3 pounds per plant; and Alpha, 2.3 pounds per plant. The largest tomatoes were produced by Alpha, Siberia, and Superarctic F1. *M. Griffith.*

Evaluation of Annual Flower Varieties

The growth and flowering characteristics of over 400 annual flower varieties were observed during the 1985 and 1986 field seasons. Data were collected on color, height, spread, bloom period, and frost resistance of all varieties. From this data base, the 200 best-performing varieties were selected as suitable for use in gardening and landscaping designs. A publication was prepared listing the 200 varieties with 1985 and 1986 field observations. In addition, appendices which list the varieties by color, height, bloom period, and special uses were prepared to assist those designing gardens. For those interested in bedding plant production, the seed sources, seeding dates, seed germination requirements, and greenhouse production techniques were also listed. *M. Griffith.*

Greenhouse Chrysanthemum Production

The potential for commercial production of potted chrysanthemums in interior Alaska will only be realized if production costs can be reduced

using such strategies as lowering the greenhouse temperatures at night. In this experiment, four chrysanthemum varieties ('Coronet', 'Twilight', 'Stoplight', 'Free Spirit') were produced as a fall crop using natural light and natural photoperiod during the period of early growth and flower initiation (Sept. 4 to Oct. 13). On Oct. 13, the mums were placed in two greenhouse rooms: one room had a night temperature of 60 degrees Fahrenheit, and the other room was held at 50 degrees Fahrenheit at night. Within each room, half of the chrysanthemums were provided with supplemental light 10 hours per day, while the other half received only natural light. Cooler night temperatures did not delay the marketability of any of the four varieties and improved the plant and flower quality in all varieties grown under natural light. Low natural light levels proved to be a more important factor causing delayed marketability and reduced flower quality for all varieties. Acceptable chrysanthemums were produced at either night temperature with supplemental light. Acceptable mums were produced under natural light only when greenhouse night temperatures were lowered. Chrysanthemums produced at warm greenhouse night temperatures and with natural light were not marketable. These results suggest that an appropriate strategy for raising chrysanthemums in interior Alaska would be to pot cuttings in mid-August to promote early growth, to shade during early September to ensure flower initiation, and to reduce greenhouse night temperatures beginning in October to improve flower quality. *M. Griffith.*

Instructional Materials on Gardening and Root Cellaring

Work to create instructional materials specific to Alaskan agricultural enterprises is underway. These materials are designed not only for use in secondary vocational agriculture and science classes but also for use in a cross-cultural context for community education programs such as those conducted by local education agencies, the Cooperative Extension Service, and/or any of the various Native corporations.

An instructional guide, *Alaskan Gardening and Root Cellaring,* has been completed. The units include basic gardening, gardening in the North, and principles of root cellaring. These are further divided into twenty-two individual lessons. The units provide background information for the instruc-

tor, specific lesson plans, and suggested activities related to the lesson. Annotated bibliographies of related resource materials pertinent to gardening and root cellaring are also included. The design of all lessons and activities take into account the potential lack of resources in a remote, rural setting, thus making the guide adaptable to a variety of settings and situations. *C. Kirts and S. Weston.*

Seed Germination of Native Alaska Iris, *Iris Setosa* ssp. *Interior*

Seeds of Alaska Iris, *Iris Setosa* ssp. *Interior* were collected from wild stands near Fairbanks and subjected to the following treatments: 0 or 125 days of stratification at 40 degrees Fahrenheit followed by a seed soak in water or 1000 parts per million gibberellic acid (GA_3). Seeds were germinated at alternating (77 and 50 degrees Fahrenheit) or constant (70 degrees Fahrenheit) temperatures and in darkness or light. After 7 days, germination was best (95 percent) with stratified seeds that were soaked in GA_3 and germinated at constant temperatures in the dark. A greenhouse study in which stratified seeds were soaked in water or GA_3 sown in a commercial peat and vermiculite seed germination mix and germinated beneath clear or black plastic confirmed that germination was highest (64.4 percent) and most uniform (83.3 percent filled container cells) with the combined treatments of GA_3 and darkness. These treatments provide the best method for obtaining high germination percentages required by commercial producers and plant breeders of wild iris. *P.S. Holloway.*

Vegetative Propagation of Native Alaska Highbush Cranberry, *Viburnum edule,* by Stem Cuttings

Stem cuttings of highbush cranberry, *Viburnum edule,* were collected from wild stands near Fairbanks at periodic intervals throughout the summer of 1986. Cuttings of current season's and one-year-old growth were

treated with a commercial IBA rooting powder and stuck into flats of perlite. Cuttings were rooted in an intermittent mist propagation bench, and the rooting percentage and rooted cutting survival were determined. Rooting was best when cuttings of current season's growth were collected on August 15 (61 percent). Rooting of one-year-old cuttings was best on the July 12 (48 percent) and August 1 (46 percent) collection dates. Survival of rooted cuttings after transplanting into potting soil was best for new growth collected on July 25 (54 percent) and August 15 (57 percent), while best survival for one-year-old cuttings was slightly earlier on the July 12 (42 percent) and July 25 (43 percent) collection dates. For best rooting percentages and optimum survival after transplanting, cuttings of current season's growth should be collected from July 12 to August 15. *P.S. Holloway.*

Native Polargrass Shows Promise As Forage under Severe Winter Icing Conditions

The 1985-86 winter provided a good test of the tolerance of some forage grasses to serious icing conditions. In trials at two different sites subject to icing, some of the standard, commercially available forages were moderately to severely injured, while an experimental native grass exhibited good tolerance of these conditions. These sites were on strongly acidic soils where timothy is the most commonly used forage grass. Other grasses sometimes used on acidic sites include meadow foxtail and reed canarygrass.

In a trial on Tustamena silt loam east of Soldotna on the Kenai Peninsula, seven varieties of timothy manifest various degrees of injury with 'Engmo' enduring the best, providing 1.53 tons per acre of yield from a 16 July 1986 harvest. 'Climax' out of Canada was the most seriously injured of the timothy varieties. Injury to reed canarygrass and meadow foxtail was so severe as to preclude harvesting. Two experimental polargrasses *(Arctagrostis latifolia)* provided the highest yields of 1.75 and 2.17 tons per acre, showing little injury.

In a trial on Rabideaux silt loam in the Bartlett hills south of Talkeetna, winter injury was severe to all five timothies in the trial, including Engmo, with a yield of 0.51 ton per acre, and was equally severe to meadow fox-

tail and reed canarygrass. As in the Soldotna trial, the experimental polargrasses provided the highest yields, ranging from 1.64 to 1.82 tons per acre for three entries.

Polargrass is a tall leafy plant that endures wet areas but also performs well on upland sites. It shows merit as a forage grass on acidic sites. It has been a fair to good seed producer in trials at Palmer and, unlike some native grasses, has been relatively easy to work with in the seed-cleaning process.

Work on different collections of polargrass has identified some superior performing populations for breeding material of a proposed forage variety. It is expected that polargrass will make a worthy contribution to the forage options for growers in areas with cool, moist growing seasons and strongly acidic soils where it has been difficult to sustain a stand of grass. It also will provide some income for Alaskan seed growers. *Wm.W. Mitchel.*

Native Alaskan Bluebunch Wheatgrass Vastly Superior To Introduced Cultivar in Winterhardiness

Bluebunch wheatgrass is a long-lived, cool-season bunchgrass utilized in the Pacific Northwest states as a native range forage. It is especially valued for its good palatability, drought resistant, and nutritive qualities.

In an earlier study, three numbered strains obtained from western states were grown in forage plots harvested twice per year. All three were poorly adapted for use in Alaska, far north of their latitude of adaptation. All produced only modest forage yields and winterkilled totally during the second or third winter.

Due to a poorly understood quirk in plant distribution two somewhat localized pockets of native bluebunch wheatgrass exist in western Yukon and in central Alaska, far north of the rest of the major native range occupied by the species. Seed was harvested from the ecotype in central Alaska and planted in replicated rows in May 1985 for comparison with the cultivar 'Secar' selected in the Pacific Northwest.

In spring of 1986, Secar averaged only 15 percent winter survival, while the native Alaskan ecotype showed no winter injury. These results are consistent with many previous comparisons in other grass and legume species, demonstrating that northern adaptation is a prerequisite for con-

sistently good winter survival in Alaska. Seed of the Alaskan bluebunch wheatgrass is being increased to be used in more extensive evaluations. *L.J. Klebesadel.*

Hardiest Norwegian Orchardgrass And Meadow Fescue Cultivars Not Winterhardy in Southcentral Alaska

Orchardgrass and meadow fescue are valuable, dependable forage grass species in Europe and in parts of Canada and the conterminous 48 states. Numerous cultivars have been developed within each species by plant breeders on both continents. However, numerous cultivars within both species that were evaluated in years past have not been sufficiently winterhardy for use in southcentral Alaska.

When North American or mid-European cultivars of perennial forages have been found inadequately winterhardy for use in Alaska in past years, cultivars from Iceland or from the northern areas of Norway, Sweden, Finland, or the Soviet Union have often provided the necessary margin of northern adaptation and winterhardiness for success in Alaska. Examples are timothy and reed canarygrass from northern Norway.

Two cultivars of orchardgrass ('Hattfjeldal' and 'Hattny') and two of meadow fescue ('Salten' and 'Salten II') obtained from Norway were planted in broadcast-seeded forage plots to be harvested at the end of the seeding year and twice per growing season thereafter. The experiment, initiated in May 1984 and terminated in September 1986, included thirty perennial grasses in ten different species.

Both orchardgrasses and both meadow fescues established well in 1984; seeding-year oven-dry forage yields in late September ranged from 1.45 to 1.80 tons per acre. However, in the spring of 1985 both orchardgrasses had 100 percent winterkilled. Salten meadow fescue was rated at 30 percent winter survival and Salten II at 60 percent. Only low forage yields were obtained from those in 1985, and weedy species rapidly invaded the thinned stands. In the spring of 1986, both cultivars sustained additional winter injury; survival rates of the thinned 1985 stands in 1986 were Salten 20 percent and Saten II 30 percent. No forage yields were recoverable from either during 1986 due to heavy weed infestation.

These results reveal that not all grasses adapted to conditions in northern Scandinavia will be winterhardy in Alaska. Inasmuch as these cultivars probably represent the most winterhardy cultivars of the two species available in the world, growers in southcentral Alaska should not attempt to grow orchardgrass or meadow fescue as perennial forages. All northern-adapted bromegrass, timothy, Kentucky bluegrass, red fescue, and creeping foxtail cultivars in the same 1984-86 experiment survived both winters well and produced high forage yields from persistent healthy stands. *L.J. Klebesadel.*

Circumpolar Forage-Crop Germplasm Acquisition And Evaluation

Many economically important perennial plant species, strains, and varieties obtained from midtemperate-latitude origins in Europe and Asia and introduced into similar latitudes in North America were well-adapted and have served agriculture well in the forty-eight conterminous states. However, numerous experimental studies have confirmed that those plant strains and ecotypes generally are poorly adapted and typically non-winterhardy when they are grown in Alaska, far north of their region of adaptation.

Cumulative evidence from numerous investigations confirms that the correct strategy for Alaskans, for plant species not native to our state, is to obtain strains or ecotypes from the northern limits of their natural ranges in Europe and Asia. Those plant materials, adapted to northern latitudes through eons of growth in the north, possess genetically controlled physiological mechanisms that confer good adaptation to similar seasonal climatological patterns in Alaska. Those subarctic climatological patterns, critically different from those at midtemperate latitudes, involve the interrelationships of growing season and seasonal daylength (photoperiod) patterns that control plant performance. Consequently, those northern-adapted ecotypes are consistently more winterhardy in Alaska than plant strains obtained from and adapted to more southern latitudes.

To capitalize on these natural principles of plant adaptation, we have accelerated the acquisition of plant materials from northern Europe for evaluation in Alaska. During 1986, we obtained 66 previously untried

strains within 7 species of grasses and 4 species of legumes from research centers and gene banks in Sweden, Finland, and the Soviet Union. These will be added to many other recent acquisitions from the same countries as well as from Norway and Iceland to be evaluated for winterhardiness and other agronomic performance criteria in future years. *L.J. Klebesadel.*

Seeding-Year Management Is Important in Promoting Highest Bromegrass Seed Yields during the Following Year

Earlier investigations established that bromegrass must be seeded as early as possible in spring to maximize heading and seed yield in the first year after planting. However, that practice produces from 1 to 1.5 tons of high-quality forage dry matter per acre during the seeding year and that forage should be harvested and utilized in some manner.

When should the seeding-year growth be harvested to promote maximum seed production during the subsequent year? An experiment was designed to evaluate four different harvest dates, as well as whether additional fertilizer nitrogen (N) should be applied beyond the 32 pounds per acre incorporated into the seedbed prior to planting.

Seeding-year forage harvest on 15 August resulted in more seed heads produced during the following year than harvests earlier (20 July) or later (14 Sept. or 5 Oct.). Topdressing with N at 50 or at 100 pounds per acre immediately after the 15 August harvest resulted in significantly higher seed yields (539 and 638 pounds of seed per acre, respectively) during the following year than where no additional N was applied (413 pounds of seed per acre). Waiting to harvest the forage near freeze-up (5 Oct.) not only resulted in lower quality forage but also caused significantly lower seed yields the following year.

These results reveal that bromegrass seed growers have seeding-year management options that should be incorporated to maximize seed yields in the year after planting. Early planting results in an appreciable yield of good-quality forage by mid-August. Harvest in mid-August not only pro-

vides a modest yield of forage in the seeding year, but also promotes maximum seed production during the following year. *L.J. Klebesadel.*

Time of Nitrogen Application Is Critical for Successful Bromegrass Seed Production

All appropriate management options must be incorporated to best advantage in promoting maximum seed yields of bromegrass if growers are to realize high yields that lead to profits.

Earlier studies have shown that fertilizer nitrogen (N) is a very critical nutrient that must be applied in proper amount to stimulate maximum production of seed heads in bromegrass seed fields. However, earlier work had not identified exactly when the N should be applied to promote maximum heading and seed production. N at the rate of 100 pounds per acre was applied on various dates as ammonium nitrate on Polar bromegrass rows established in June 1973. The N was applied to small plots on ten different dates from 18 April 1985 to 16 June 1986 to compare the effects on the seed crop harvested in August in 1986.

The ideal date for N application of all compared was 27 August 1985, shortly after the 1985 seed harvest, but a full year before the 1986 seed harvest. Application of N on 27 August 1985 resulted in 2.6 times more seed in August of 1986 than did application on 19 April 1986. The 1985 date was 7.6 times more effective than applying the same amount of N on 28 May 1986. This discovery is apparently unique to high latitudes, for bromegrass seed growers in the lower 48 states can apply N in spring of the year of seed production with good success.

These results emphasize the importance of conducting extensive research studies in Alaska in order to solve problems unique to the genetic and climatic conditions inherent in Alaskan agriculture. A grower of bromegrass seed who moved to Alaska from South Dakota or Nebraska and followed fertilization practices for bromegrass seed production appropriate for his former midwest farm would be assured of failure in Alaska. *L.J. Klebesadel.*

Stubble Management after Seed Harvest Strongly Influences Bromegrass Seed Yield the Following Year

Combine harvest of bromegrass seed at maturity typically leaves a tall, leafy stubble about 12 to 20 inches tall. Although the stubble consists of a relatively stemmy, low-quality forage (typically 5 to 8 percent crude protein), it could be harvested and fed to certain classes of livestock. If the bromegrass stand is to be utilized for continued seed production, how should the tall stubble be managed to favor maximum heading and seed production during the following year? Five treatments, imposed shortly after seed harvest in 1985, were compared for influence on seed yield in 1986 to answer this question.

Treatments evaluated included (a) stubble left in place (until clipped and removed after autumn freeze-up), (b) stubble clipped to 6-inch height and left in place, (c) stubble clipped to 6-inch height and clippings removed, (d) stubble clipped to 2-inch height and clippings left in place, and (e) stubble clipped to 2-inch height and clippings removed.

As measured by seed yield in 1986, treatment (e) was superior to all others. That management option resulted in 4.4 times higher seed yield than treatment (a), the poorest procedure. Clipping the stubble to a 6-inch height with removal of clippings (treatment c) was the second-best procedure, but resulted in seed yields only 65 percent as high as treatment (a).

These results confirm that proper post-harvest stubble management is an important influence in promoting continued high yields from bromegrass seed-production fields. The stubble should be clipped short and removed from the field shortly after combine harvest, regardless of whether it is used for feed, bedding material, or simply discarded. *L.J. Klebesadel.*

Crop Uptake of Residual Fertilizer Nitrogen

A recently completed field study indicated that about 40 percent of the nitrogen (N) applied as urea at a rate of 90 pounds per acre to an interior Alaskan 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. At present, plant and soil samples are being prepared for N-15 analysis, thus 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.*

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 locally. 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 is to determine whether the use of anhydrous ammonia as a N fertilizer for small grains is feasible in interior Alaska. The secondary objectives are 1) to compare barley response to anhydrous ammonia with that of urea and ammonium nitrate, all applied at the same rate of N, 2) to compare barley response 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 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 study. Anhydrous ammonia is applied at a rate of 90 pounds N per acre in the fall and in the spring, and urea and ammonium nitrate are applied in the spring, also at 90 pounds N per acre. Barley is used as the test crop. Soil samples

are collected throughout the growing season from the plots, and plant samples are collected at physiological maturity. The soil samples are analyzed for ammonium and nitrate to determine the rate of nitrification (conversion of ammonium to nitrate). The plant samples are 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 N content are measured.

In 1986, the second year of the study, grain yields at Fairbanks for the N-fertilized plots were about double that of the plots receiving no N fertilizer; there were no differences in grain yield due to the kind of N fertilizer used or the time of application for the ammonia. At Delta, no N fertilizer response was noted, probably because the major factor limiting barley growth was the very acidic condition of the soil. Soil analyses for Fairbanks have not yet been completed. At Delta, by mid-May, slightly less than half of the inorganic N in the fall-applied ammonia had nitrified. Nitrification in the urea plots appeared to have occurred slightly faster than in the spring-applied ammonia plots as evidenced by the rate of disappearance of ammonium and accumulation of nitrate. By mid-June, nitrate levels were low in all plots, probably due to plant uptake; ammonium levels near the zone of application remained slightly higher in the spring-applied ammonia plots than in the control plots until about July 1.

Should this study show that anhydrous ammonia is a good N fertilizer for production of small grains in Alaska, considerable savings in fertilizer costs could result for the Alaskan farmer. Knowledge of the nitrification rates of fall- and spring-applied anhydrous ammonia will lead to efficient management practices for this fertilizer in interior Alaska. *S.D. Sparrow.*

Statewide Phosphorus Soil Test—Field Calibrations

A study of the phosphorus(P)-sorption character of ten representative soils indicated that they could be divided into two distinct groups based on parent materials. The first and highest P-sorbing group identified was the volcanic ash soils from Kenai and the Susitna Valley with an average P-sorption maximum of 10122 parts per million. The second and lower P-sorbing group was the loess soils from Delta Junction, Fairbanks, Kenny Lake, and Matanuska Valley, with an average P-sorption maximum of

3945 ppm. A growth chamber study was conducted to identify the suitable extractant for the ten soils as a whole. The Mehlich 3 extractant proved to be the most suitable from a group of seven commonly used P extractants.

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 cropping was planted in the spring of 1985. Uniform nitrogen (N), potassium (K) fertilizers (120 lbs N/acre as urea, 62 lbs K per acre as potossium 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 2 years of cropping, the general increase in correlation coefficients and/or confidence levels for the relationships between yield and Mehlich 3 extractable P indicates soil conditions for soil test calibration remain good and have improved over 1985. The change in soil test values from 1984 through 1985 indicate that dissolution and equilibrium of fertilizer P are still taking place at sites with high P treatments while soil P depletion has begun at the Delta Junction sites. More data will be necessary for confidence in the determination of soil test P critical levels especially for such sites as the Matanuska Valley and Kenney Lake areas. *C.L. Ping.*

Soil Test Correlations for Alaska Soils

A study has been completed on the extraction of plant-available phosphorus (P) from representative Alaska agricultural soils. The relatively new multielement Mehlich 3 extractant was found to extract amounts of P highly correlated to plant growth. The adoption of this extractant was recommended based on the high degree of correlation for all soils studied and the fact that laboratory operations would be more efficient with multielement extraction. Field calibrations using the Mehlich 3 extractant are underway at nine locations statewide. A laboratory study is near com-

pletion which will correlate Mehlich 3 extractable P and cations potassium (K), calcium (Ca), and magnesium (Mg) with soil test methods currently being used, which are the Bray 1 and ammonium acetate methods respectively.

Preliminary Mehlich 3 data indicate a high degree of correlation with both Bray 1 P and ammonium acetate cations on all nine agricultural soils under study. Regression coefficients for extractable P and all three cations were significant. Regression coefficients for Mehlich 3 vs. ammonium acetate extractable K and Mg were also high. Extractable Ca varied in magnitude among soils to a much greater degree than the other elements. Correlations between Mehlich 3 and ammonium acetate extractable Ca were also more variable. Soils with a high Ca content, such as those in the Matanuska Valley and Copper River areas, had lower regression coefficient values. The regression coefficients for all the elements tested are significant at the 1 percent level. With these results, adoption of the new Mehlich 3 extractant in our laboratory could begin as early as the winter of 1987. *C.L. Ping.*

Fertilizer-Rate and Cutting-Stage Effects On Yield and Quality of Toral Oat Forage

Farmers at Pt. MacKenzie rely a great deal on annuals, mainly oats, for forage. For high-quality forage, however, they must cut the oats in the early stages of development and accept lower yields than if they had cut in the later stages. In a trial conducted in 1986 at Pt. MacKenzie, the effects of three nitrogen (N) rates and two phosphorus (P) rates were tested on 'Toral' oats at three harvest dates.

Harvests were conducted at head emergence on July 28, when fully headed on August 8, and in late milk stage on August 20. Average yields for all treatments at each cutting were 1.62, 2.30, and 3.14 tons per acre, respectively. Average crude protein (CP) percentages declined from 15.5 percent at head emergence to 12.8 percent and 10.6 percent at the later harvest stages, respectively. The higher N rates of 90 and 120 pounds per acre generally produced only 3 to 7 percent increases in yield over the 60-pound rate. However, the 90-pound rate of N increased crude protein values 19 percent and 26 percent over those at the 60-pound rate

at the fully headed and late milk stages, respectively. The 120-pound rate produced 13 and 3 percent increases in CP over those at the 90-pound rate at the last two cuttings. N rates had no effect on digestible dry matter percentages, which averaged 65.7, 60.0, and 59.6 percent from the earliest to latest cutting dates. The higher P treatment of 120 pounds P_2O_5 per acre provided no advantage in yield or quality over the 80-pound rate.

According to this and some preceding research, a farmer must weigh the merits of 1.5 to 2.0 tons per acre yield with about 12 to 15 percent CP and 60 to 65 percent digestibility of material cut in the head emergence to fully headed stage against about 3 tons or more per acre yield with about 7 to 10 percent CP and 55 to 60 percent digestibility cut in the milk to dough stages. Though the higher N rates did not improve yields appreciably over the 60-pound rates, their production of 10 to over 20 percent increase in crude protein content warrants consideration in a forage management program. The research indicated that 80 pounds or less P_2O_5 per acre was sufficient. *Wm.W. Mitchell.*

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

An agronomic experiment was conducted to determine the effect of disposing of and utilizing dairy slurry manure on oat silage yields grown in a subarctic environment. Application rates sufficient to supply nitrogen (N) at three rates (40, 80, and 160 lb/A) under three techniques (broadcast, incorporate, and inject) were evaluated for both dairy manure and urea.

The second-year results of oat yields showed significant differences in the urea plots with the highest rates producing the highest yields. There were no significant differences between the sources of N. The general trend among techniques when ranked by highest yield was incorporate, broadcast, and injection. All interactions were significant.

The soil samples indicate no build up of nitrate in the 6- to 12-in level over time which means no ground water contamination from the high application rates of manure. Most of the organic manures remain in the surface to 6-in depth. Higher yields were obtained on the manure plots in the second year than the first year due to the slow release of more am-

monium (NH_4) and nitrate (NO_3^-) and the additional amounts of manure applied. Injection did not distribute the N source uniformly across the plot as indicated by bands of dark green forage between yellow forage. *R.F. Cullum, C.L. Ping, and G.J. Michaelson.*

Fertilizer Savings Indicated by Phosphorus-Extraction Capabilities of Timothy

The moderately to strongly acidic soils in the Pt. MacKenzie area are known for their strong phosphorus(P)-fixing characteristics. High P treatments can be used to counteract some of the adverse effects, but P is the most expensive ingredient in fertilizer. Currently, P is often applied at 80 to 100 pounds P_2O_5 per acre on farms at Pt. MacKenzie.

Grasses vary in their ability to cope with the potentially growth-inhibiting properties of low pH and bound P. In 1985 a trial was established at Pt. MacKenzie with the perennials 'Engmo' timothy, 'Manchar' bromegrass, and reed canarygrass at P rates of 40, 80, 12, and 160 pounds P_2O_5 per acre, with nitrogen (N) and K_2O applied at 90 and 80 pounds per acre respectively. All three grasses responded to P treatments up to 120 pounds P_2O_5 per acre in their establishment year with reed canarygrass providing up to 2.2 ton dry matter per acre, greatly exceeding Engmo timothy and Manchar brome in yield. The fertilizer treatments were repeated in 1986. Reed canarygrass was seriously winter injured, and its first-harvest yields in 1986 were relatively low, showing responses up to 160 pounds P_2O_5 per acre. Bromegrass also responded to increasing levels of P up to 120 pounds P_2O_5 per acre. Engmo timothy, however, showed no response to P above the 40-pound rate, producing 2.4 tons per acre at 40 pounds P_2O_5 per acre and averaging 2.4 ton for the four treatments. Timothy produced 2.3 times the yield of bromegrass and 4 times the yield of the winter-injured reed canarygrass at 40 pounds P_2O_5 per acre.

Though greatly exceeding bromegrass in yield, timothy about equalled it in crude protein content, averaging 13.4 percent for the four treatments; the very low yielding reed canarygrass averaged 17.0 percent crude protein. Engmo timothy averaged almost 65 percent digestibility. The rate of P appeared to have little or no effect on these values.

Thus this research indicates that the superior P extraction capabilities of timothy can enable the Pt. MacKenzie farmers to economize in their fertilizer program with lower P applications than is often applied. Further, the lower P treatments do not appear to be at the expense of forage quality. *Wm.W. Mitchell and G.A. Mitchell.*

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

Barley is the main cereal grain grown in Alaska as a livestock feed. Due to its higher fiber and lower fat levels, it provides less available energy than corn when utilized in swine diets. In addition, the fiber content will increase with a reduction in test weight and will decrease with a removal of the hull. Recently, a hulless variety 'Thual' was developed and released in Alaska that contained significantly less fiber than the covered varieties. However, little information was available on the feeding value of 'Thual'.

A growth trial was conducted with 65 Yorkshire × Landrace pigs from 52 to 220 pounds body weight to compare diets containing the hulless variety Thual at three test weights to its closest covered isoline 'Otal' and a standard basal corn-soybean meal diet. Dietary crude protein (CP) levels were maintained at 16 percent (0.70 percent lysine) until pigs reached 125 pounds of body weight and were then changed to 13 percent (0.57 percent lysine) by increasing the grain and decreasing soybean oil meal (47 percent CP) in proportion to maintain the same ratio to 220 pounds of body weight. Test weights for the three Thual barleys were 60, 53, and 49, and Otal barley was 51 pounds per bushel. The heavy Thual barley had a lower acid detergent fiber level and a greater fat content (2.8 and 2.0 percent, respectively) than the two lower test weight Thual samples (3.2 and 1.7 percent, respectively) and the Otal (6.4 and 1.6 percent, respectively).

There was no significant difference in the rate of gain for the five diets (range 1.72 to 1.83 pounds per day). A difference was present in the efficiency of gain (pound feed per pound body weight gain) for the diets containing corn, Otal, and the heaviest through the lightest Thual barleys of 3.03, 3.41, 3.31, 3.74 and 3.54, respectively. Although corn was at least 10 percent more efficient than the barley diets, it did not provide any advantage for daily gains. There was no advantage to feeding Thual when

compared to the covered variety Otal containing higher fiber. However, Otal barley was a high-quality sample with a 51-pound test weight. As the test weight of the Thual barleys declined, the feed conversion was reduced. When Thual barley is included in growing-finishing swine diets, the purchaser should obtain information about the test weight in addition to moisture and protein content. *F.M. Husby.*

Acceptability of Straw and Salmon Meal in Rations for Milk Production

Diets for Alaska dairy cattle include grass and small-grain roughages that often have less than 10 percent crude protein (CP). Consequently, concentrates used in these rations must be at least 18 percent CP to achieve the 16 percent CP in the total diet necessary for lactation. In this study, in each of three years, fifteen Holstein cows in weeks 3 through 19 of lactation were fed one of fifteen different rations in a 3 by 5 factorial design. The first factor was roughage: 100 percent barley/oat silage, 50 percent barley/oat silage plus 50 percent strawmix (a straw, beet pulp, molasses, and mineral mixture), or 100 percent strawmix. Soybean meal was replaced with salmon meal as the major protein source in the concentrate. This study was completed in 1986, and data analysis is continuing. Preliminary analysis shows a decrease in intake, pounds of milk produced, and in efficiency with strawmix roughage. Analysis will continue in 1987. *L.B. Bruce.*

Plant and Marine Waste 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 (CP), 7 to 10 percent, compared to roughages such as alfalfa with 17 percent CP. Therefore, the concentrate portion of the Alaska dairy cow's diet must be high in protein as well as energy.

Alaska salmon meal, with 60 percent CP, is a considerably more concentrated protein source than soybean meal with 48 percent CP. 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 a reduction in the fat content of milk produced by cows fed concentrates containing salmon.

Our study is designed primarily to determine the effects of replacing soybean meal with salmon meal in the dairy cow's concentrate. We have placed cows on five different rations with 0, 25, 50, 75, or 100 percent replacement of soybean meal with salmon meal. A total of forty-five cows have been studied over a period of three years. The study was completed in 1986, and data analysis is continuing in 1987. Preliminary analysis shows a linear decrease in milk fat percent with increasing salmon meal. Milk production was increased with salmon meal and dietary intake de- Analysis will be completed by 1987.

Last summer, we augmented our main lactation study with an intense study on twenty Holstein cows. This included five cows in each of four treatment groups. This study included weekly fecal, blood, and rumen fluid collections. The cows were fed one protein source from two weeks prepartum to four weeks postpartum and then were switched to the second protein source for six more weeks. The treatment groups were: 1) salmon meal then soybean meal, 2) soybean meal then salmon meal, 3) salmon meal for the entire period, 4) soybean meal for the entire period. Lab and data analysis is ongoing.

This year the intensive study will include five cows on each of the five experimental concentrates for a period of two weeks prepartum and fifteen weeks postpartum. Biweekly fecal, blood, and rumen fluid samples are being collected. The cows' performance also will be monitored as they return to the herd after the experimental period.

A total of forty Holstein heifers and forty Holstein steers have been fed the five concentrate diets listed above in groups of four, from 8 weeks to 1 year of age. No differences have been found for weight, wither height, or paunch and heart girth. *L.B. Bruce.*

Matanuska Valley Breeders' Association

The Matanuska Valley Breeders' Association (MVBA) is a nonprofit corporation, organized by Alaska's dairymen in 1948 to increase the genetic potential of dairy herds by using the superior sires available through artificial insemination. MVBA makes available semen from both dairy and beef bulls. In 1985, MVBA became the state organization responsible for Dairy Herd Improvement, a national program maintaining production records through monthly milk testing. The extension responsibilities for this program are handled by the Cooperative Extension Service, and the day-to-day functioning of the program is done by MVBA's Board of Directors.

The AFES Animal Sciences Program provides support to MVBA by managing the routine monthly activities and handling monthly billings, banking, payments, and ordering supplies and semen. *L.B. Bruce.*

Beef Production in Alaska

One of the major problems for Alaskan beef producers is adequate winter forage for beef cattle. Two groups of five beef cows were used in a study of the use of Alaska barley to replace hay as a winter feed. Two rations were designed: the first was primarily brome hay, and the second was primarily barley. To insure isonitrogenous and isocaloric intakes the barley ration was limit fed. Cows received either 20 pounds of hay ration or 14 pounds of barley ration per head per day. Cows on the barley ration gained similar amounts of weight, were equal in maternal ability, and survived the winter with equal degree of ease compared to the hay group. Cattle wintered on barley require careful ration formulation and feeding, but with good husbandry practices they do well. Barley can be used as the major component in a wintering ration, and further research is being conducted with alternate wintering feeds. *L.B. Bruce.*

Dietary Selenium in Supplementation for Beef Cattle

Feedstuffs grown in Alaska are typically deficient in selenium (Se). A study was conducted with ten head of Alaskan beef cows during the winter to compare two methods of Se supplementation. The cattle were pastured in the summer on grasses with low Se content. For the winter season, the cattle were gathered and blood samples taken. Blood analysis for Se showed the average content to be 20 parts per billion (ppb). The normal is about 100 ppb. The cattle were then split into two groups, one fed a ration containing .5 pound per head per day of Se-rich soybean meal and the other group a ration composed entirely of Se-deficient Alaskan feeds. Three of the cows in each dietary group were then injected once a month with 10 milliliters of injectable Se.

The cattle were weighed and blood samples taken monthly. Dietary intake was closely monitored. The feeding and injections began in mid-December and carried through until April. During that time, the monthly injections of Se raised the Se content of cow blood to 70 ppb, and the soybean meal raised blood levels to 50 ppb. These treatments improved the cows' Se status, but they were still below the desired level of 100 ppb. The study shows that Se can be successfully supplemented with an Se-rich dietary supplement or by injection. Further research is being conducted to determine the correct supplementation levels. *L.B. Bruce.*

Mathematical Evaluation of the California Net Energy System

Use of net energy to balance beef cattle diets for specific intakes and average daily gains is difficult because feeds are utilized differently for maintenance and gain. Rations balanced on net energy for gain (NEg) only, on an average of NEg and net energy for maintenance (NEm), or on a weighted average of NEg and NEm are approximations which may be erroneous. 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 the National Research Council was evaluated. This equation was in-

corporated 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. This is a crucial development in the next stage of this project in which a set of algorithms will be developed to allow the calculation of least-cost feeding programs instead of just least-cost dietary formulations. *L.B. Bruce.*

Applied Reindeer Research Program
Animal and Herd Management

A long-standing concern on the part of reindeer herders as well as university scientists has been the loss of fawns due to injury and high stress on all reindeer during spring handlings. Economic considerations suggested that spring handlings are an integral part of reindeer operations, so new approaches were needed. During the past summer two major modifications were made within a cooperator's corral in an effort to reduce losses and stress.

First, a temporary "hook" was designed and put into place. This hook allows one to move reindeer out of the main holding corral into the smaller handling pockets with the reindeer milling very little, if any, resulting reduced stress on the reindeer.

The second modification incorporated a fawn separator at the beginning of the smaller handling pockets. This separator removes the small fawns and shunts them down a completely separate shoot and handling system from the adults. Previous experience resulted in numerous fawns being injured in the smaller pockets as the adults milled in their typical fashion. The fawn separator system completely eliminated fawn losses due to handling injury.

Drawings for possible facilities and a major reindeer herder workshop are being developed for this June to demonstrate these new approaches to the industry. *A. Epps.*

Epidemiologic, Pathogenic, and Serologic Investigations of Brucellosis in Alaska

Work continues on the use of a vaccine to control brucellosis in reindeer. The vaccine undergoing testing in 3500 reindeer on the Seward Peninsula of Alaska is a killed homologous vaccine in adjuvant developed by UAF laboratories and the USDA laboratories at Ames, Iowa. Its use on the reindeer follows demonstration of good protection in the laboratory. Brucellosis is caused by *Brucella suis* type 4 and is specific to the circumpolar areas of the world. It is endemic in herds of reindeer, caribou, and their predators in Alaska. There is also serological evidence of the disease in arctic ground squirrels, seals, and polar bears. Reindeer herding is an important part of the income for Alaska's Native peoples, and control of brucellosis will aid in their development of the reindeer industry. *R.A. Dieterich.*

Digestibility of Sled Dog Diets Containing Hulless Barley and Herring Meal

In North America, sled dog racing has been recorded since the mid-1850s. Since the early 1900s, sled dog races have been conducted in Alaska. The longest, continuous, organized races have been held in Fairbanks where the sport is currently celebrating its sixtieth anniversary. Most of the races in Fairbanks and Alaska are sprint races, but there are several major distance or endurance races in the state, including the Iditarod and Yukon Quest. Regardless of the type of race, sled dog selection and breeding, training, routine management, and feeding are all important in the development of a competitive team.

Historically, mushers prepared and cooked their own dog food that had been mixed from a broad selection of ingredients. The ingredients usually included meat and/or animal by-products, fat, a cereal grain, such as pearled rice, and a source of minerals and vitamins. Several dog food manufacturers have recently developed high-performance complete dry dog foods. These feeds are routinely formulated to contain 30 percent crude protein and 20 percent fat from high-quality feed ingredients to maximize the digestibility and nutrient availability. The remainder of the feed

is balanced from a cereal grain (usually corn, rice, or wheat) and mineral and vitamin supplements. The need to include highly digestible ingredients is emphasized when we consider that sled dogs racing in the cold winter months may require three to four times the maintenance level of feed intake.

A previous report from the Alaska Agricultural and Forestry Experiment station indicated that 'Thual' hulless barley and herring meal from Alaska were successful substitutes as the sole cereal grain and main protein source, respectively, in sled dog diets with a dry matter digestibility of 77.4 percent. However, we also wanted to determine the protein, fat, and carbohydrate digestibility of the barley-herring meal diet and to assess the effect of presoaking barley on its digestibility and of wheat replacement for barley on dry-matter digestibility.

This study was designed to compare the digestibility of four dog diets formulated with Thual barley or hard red wheat as the carbohydrate source, herring meal as the main protein source, and human-quality pork lard as the major energy source. All diets were processed by dry extrusion, and two Thual diets had reconstituted the barley with sufficient water to exceed 15 percent prior to extrusion to determine if the process would enhance starch gelatinization. All diets were formulated to contain 30 percent crude protein and 20 percent fat and were balanced for minerals, vitamins, and fiber. Three sprint and three distance mature sled dogs averaging 50 pounds body weight were housed in individual pens on solid concrete floors. All test diets were fed at 12 ounces daily each morning with free-choice water. A minimum of a 6-day diet adjustment period was followed by a 5-day total fecal collection period. Feces and diet samples were oven dried at 220 degrees Fahrenheit, and dry-matter digestibilities were calculated. Proximate components were determined on the feed and feces samples for the unsoaked Thual barley and wheat diets, and protein, fat, and nitrogen-free extract (carbohydrate) digestibilities were calculated.

Percent dry matter digestibilities of the Thual barley, two presoaked Thual barley, and wheat diets were 76.3, 75.5, 77.1, and 76.6 percent, respectively. There was no difference in the digestibilities, and the slightly higher values for one presoaked barley and wheat were related to a lower crude fiber content in those diets. The unsoaked barley and wheat diets had crude protein, fat, and nitrogen-free extract digestibilities of 83.0, 94.8, and 77.0 and 85.8, 93.1, and 80.6 percent, respectively. The substitution of wheat for barley appeared to improve the starch digestibility, and the

stools contained less water than those produced by dogs fed barley diets. Presoaking of the barley did not appear to improve the diet dry-matter digestibilities. These trials substantiate the previous research that Thual barley and herring meal at the levels tested can be included successfully in diets for mature working dogs. *F.M. Husby.*

Forest science research at the Agricultural and Forestry Experiment Station includes studies on forest productivity. This set of disks from a sectioned tree will be measured in the laboratory to determine growth rates as part of a growth and yield study of native tree stands in interior Alaska. (AFES staff photo)

Forest Science

Controls of Nitrogen Cycling in Secondary and Primary Successional Forests in Interior Alaska

Research dealing with the control of forest soil nitrogen (N) dynamics has been conducted in upland, secondary successional forests and in floodplain, primary successional forests. N cycling in the upland ecosystems is largely dominated by the fire return frequency, a period estimated for interior Alaska to range from 50 to 200 years. N cycling on the floodplain reflects the frequency of inter- and intraseason flooding and sediment deposition and the occurrence of N fixation by alder early in the successional hierarchy.

The consequences of fire for soil nutrient reserves, depend on the severity of burn. Recent work on the Rosie Creek fire indicates that up to half of the original N reserves may be lost from the forest floor in the most severely burned white spruce and aspen sites. In contrast, forest floor pH increased at least an order of magnitude in all forest types. This was associated with increases in calcium (Ca), magnesium (Mg), potassium (K), and phosphorus (P). Decomposition rates of residual soil organic matter also were markedly increased over unburned forest conditions. Estimates of net N mineralization and nitrification in the forest floor and surface 4 inches of mineral soil generally show increases in supply of mineral N. The potential impact of these changes in soil fertility on growth and production of the next generation of trees in post-burn white spruce is being evaluated with a field bioassay using white spruce seedlings. Results from year 2 show that seedlings planted in burned locations grew

nearly 30 percent more in height and accumulated twice as much biomass in top material as the control seedlings. The growth response was associated with a fourfold increase in N supply in the rooting zone under the burned conditions. The results generally indicate a marked improvement in soil fertility for seedling spruce growth following burning. The value of fire as a management tool in seed bed preparation and in promotion of early seedling growth needs further evaluation. Competition for soil water and nutrient reserves between weedy and desired species is an important consideration in this regard.

On the floodplain, element dynamics in early successional stages reflects physical-chemical control of ion concentrations through capillary rise of ground water and its evaporation on the soil surface. The resulting surface soil salt concentrations approach 10,000 ppm SO_4 in saturation extracts. The minerals associated with the high salt content surface soils include $CaSO_4$ and $CaCO_3$. The upward movement of ions in soil solution was recently demonstrated in field experiments. High concentration NaCl solutions were used to trace the upward movement of the soil solution. One month following the injection of a 10,000-part-per-million salt solution at 10 inches in the soil profile, sodium and chloride ions could be detected in the surface 2 inches of mineral soil. Because there was no plant cover on this soil, surface evaporation of soil solution must have contributed to maintaining a strong, upward soil moisture suction gradient. Application of a litter layer to the surface in a series of the injection treatments essentially stopped upward movement of soil solution. Surface evaporation was probably inhibited in these cases. These positive results are the first tests of the potential importance of capillary rise of water from a high water table as a mechanism in pedogenic salt formation in subarctic forest soils. Moreover, the tests demonstrate a possible additional source of water and nutrients for plant use.

In later successional stages, soil N dynamics appear to reflect the nature of the vegetation types and their ability to add N through fixation or modify and even inhibit rates of N cycling through the production of secondary plant chemicals. During the alder stages of succession, fixation of N results in dramatic increases in soil N content. Field estimates of rates of nitrification are up to fifty times greater than those encountered in later successional stage soils. Following the alder stage of succession, poplar *(Populus balsamifera)* and white spruce *(Picea glauca)* become the dominant species. The tannin content of poplar leaf tissue and of the 021 and 022 layers of the forest floor of mature poplar stands may increase between

two- and threefold over the condition encountered in the alder stands. An increasing presence of tannin associated with successional change in forest types may play an important role in modifying soil N dynamics in these floodplain ecosystems. *K. Van Cleve.*

Silvics

Selection of the tree species best suited to the site is the most important decision a forest manager must make. Research during 1986 continued to emphasize tamarack. Tamarack and other specie of larch are attracting increasing attention. In the Great Lakes states they are a preferred species on many sites. Both bare-root and container nursery stock produce good-quality seedlings. Tamarack provenances were observed in British Columbia, Yukon, and southwestern Northwest Territories. One provenance, the Liard River Hot Springs, showed exceptionally fine form and size; most provenances were typically unimpressive although there were good individuals at each location. This strongly implies that genetic selection of trees between and within populations plays a major role in the regeneration effort.

Lodgepole pine provenances were also observed at the same time. In northeastern British Columbia near the Fort Nelson River bridge, a mixed stand of lodgepole pine and jack pine was located with many trees appearing to be hybrids of the two species.

A search of the literature for fungal associates of tamarack continues. The pathogen of major concern is that which causes larch canker. *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 the northern forest of interior and southcentral Alaska. Im-

mature white spruce have been found with impressive diameters; e.g., one 42-year-old tree had a breast height diameter of 16 inches and a 77-year-old tree had a breast height diameter of 19 inches. This demonstrates that certain sites in the northern forest of Alaska are capable of excellent growth and are competitive with those in other circumpolar countries.

A large number of stands containing tamarack were visited in Alaska and northwestern Canada. Tamarack over 12 inches in diameter at breast height were rare; however, at one unique site having extremely warm soils because of the adjacent hot springs, trees in excess of 12 inches were common with one having a diameter greater than 20 inches. Tamarack with diameters of 16 inches are reported to occur on good sites in southeastern Yukon. No age data are available for these large tamarack.

Final assessment of field data confirms that established seedlings (.5 foot tall) of tamarack and hardwood grow at considerably greater rates than white spruce. On many sites, tamarack grows as fast as hardwood associates reaching breast height within 2 to 4 years; on most sites white spruce requires 6 or more years, and black spruce averages 12 years. Nursery-grown tamarack seedlings attain heights greater than .5 foot late in the first growing season following germination. These data demonstrate the need for specific silvicultural strategies to ensure that spruce plantations and natural regeneration are not overtopped and suppressed by competing hardwoods. Also, tamarack should be considered a viable conifer option on suitable sites where hardwood competition is anticipated.

Height-over-age curves for tamarack confirm that published site index curves (curves used to assess the potential productivity of the site) for tamarack are invalid. A major concern with our data is the small number of sample trees which are older than 50 years; to develop and test new site index curves, a minimum of 50 to 100 trees older than 50 years are required. Until the accuracy of site index curves based on Alaskan data has been tested independently, published curves for all species are suspect.

Three (two white spruce and one tamarack) levels of growing stock (LOGS) plantations were established in late May 1986. Two-year-old container seedlings were planted at five spacings (4 by 4, 6 by 6, 8 by 8, 10 by 10, and 12 by 12 feet) for spruce and four spacings (4 by 4 spacing excluded) for tamarack. First growing season survival data were collected and will be compared with spring 1987 survival. These LOGS plantations are the most northern in North America and should provide the forest

manager with long-term survival, growth and yield information, and optimum spacing guidelines and provide the researcher with a basis for comparing results of studies implemented much further south.

The energy content of the tree species north of the Alaska Range was determined in the laboratory; these data are being summarized and will be compared with published values. Energy content of fuelwood is of concern to the industrial user and should be of concern to the individual consumer; currently, fuelwood prices do not necesarily reflect the energy content. The specific gravity (the ratio of the weight of a given volume of dry wood to the weight of an equal volume of water) of these samples was also determined. Specific gravity provides information concerning the amount of solid material present in a cubic foot of wood as well as information regarding wood strength. Such information is important for buying and selling stumpage and logs as well as marketing processed wood products. *E.C. Packee.*

Analysis of Long-Term Forest Productivity Using Computer Simulation Models

FORCYTE-10, an ecosystem-based forest management, growth and yield model was selected to investigate the effects of intensive management of taiga white spruce on future site productivity. A series of management simulations made with the model indicated that intensified management may increase site productivity, but the increase may be, in part, a result of the nitrogen (N) input by alder that invades the site after clearcutting.

An additional series of simulations designed to look specifically at the importance of alder indicated that, in both whole-tree and stems-only harvesting schemes, symbiotic N fixation was important in maintaining ecosystem productivity. Additionally, the added importance of maintaining a pool of easily mineralized N on the site after clearcutting was indicated by comparing whole-tree harvesting to a stems-only harvest.

A second model, LINKAGES, which embodies a different philosophical and structural approach, has also been calibrated for interior white spruce ecosystems. A management routine is currently being written to enable

the comparison of predictions of long-term productivity under various management scenarios. *J. Yarie.*

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

Regression equations were developed for the major understory species found in southeastern Alaska to predict twig, foliage, and combined biomass. The equations will be used to predict biomass from visual estimates of percent cover by 1-foot layers for a vertical profile extending from ground level of 16 feet. These equations will be combined with the vertical-profile measurements made by the US Forest Service, Forest Inventory and Analysis Unit, to develop detailed profiles of the amount and availability of understory species. These profiles are then useful in determining the quality of wildlife habitat in various communities across the state. *J. Yarie.*

Forest Products

The northern forest (spruce-birch-aspen-poplar) resource of Alaska contains a volume of timber slightly less than that of Wisconsin but greater than that of Minnesota. The potential for development of this Alaskan resource into a viable forest industry capable of competing for world markets is strongly debated. Such resources support an industry elsewhere in North America often with similar access problems and equal or greater distances to markets.

Alaska white spruce manufactured into quality lumber at efficient mills could replace much of the construction lumber imported into Alaska. Quality Alaska hardwood logs and boards could displace some materials being exported from North America to Pacific Rim countries.

A major impediment to marketing northern forest species from Alaska is confusion and, in some cases, prejudice concerning their lumber and

fibre characteristics. For example, it is commonly stated that Alaska white spruce has an excessive amount of spiral grain, whereas Canadian white spruce has little or none. However, 25 to 99 percent of western conifers have spiral grain. There is no published quantitative data that compares spiral grain of white spruce in Alaska with that in Canada.

Without information on the characteristics of Alaska's northern wood species, it is difficult to sell Alaskan forest products in an extremely competitive world market. A summary of information concerning these characteristics should be published during 1987.

In Alaska, there is concern about the way the state determines stumpage prices; many purchasers of stumpage consider the prices to be too high. They cite the lower stumpage prices in Canada to support their argument. A graduate student in the UAF School of Management is investigating stumpage appraisal methods and comparing methods used for northern species in Alaska with those used in British Columbia and the Yukon Territory. A report is anticipated by mid-1987 which will provide recommendations regarding possible changes to the appraisal methods to make them more equitable for all parties. *E.C. Packee.*

Estimation of the Potential Timber Volume In the Tanana Valley Available for Conversion to Chip Fuel

This project, initiated in April 1986, was a cooperative effort between the University of Alaska-Fairbanks, USDA Forest Service, and the Alaska Power Authority. Funds from the Pacific Northwest and Alaska Bioenergy Program managed by the APA were used to conduct this timber evaluation as part of the ongoing evaluation of the potential for generating electricity with wood chip fuel in interior Alaska. The primary objective of the project was to identify the types and total volumes of timber on selected lands in the Tanana Valley. A secondary objective was to estimate the costs of producing and delivering wood chips in this region. The study lands covered an area of 2.5 million acres and included Tanana Valley State Forest Lands, Native lands, military lands, and agricultural disposal lands. We found that the forested lands in the study contained an estimated volume of nearly 9 billion cubic feet of standing timber which could be

converted to wood chips. A sustainable volume in excess of 424,000 tons per year could be harvested from these lands. This is thirteen times the maximum estimated consumption of chips by one power plant burning a mixture of 15 percent chips and 85 percent coal. The economic analysis indicated that the chips could be delivered at a price ranging from $19.35 to $24.11 per green ton. The final report covering the results of this study will be available through the Alaska Power Authority. *A.P. Richmond, A.F. Gasbarro, and G. Sampson.*

Large—Scale Wood Chip/Coal Test Burn At Fort Wainwright, Alaska

Over the past three years, the University of Alaska-Fairbanks and the USDA Forest Service have been working to determine whether or not local power plants can burn a mixture of wood chips and coal without major modifications to the boilers. If a large market can be developed for wood chips, the Alaska Division of Forestry and other major land owners in the Tanana Valley could more effectively manage their forest lands for the production of wood. This study was undertaken to determine the maximum mixture of wood chips and coal which can be fed into boilers using the existing stoking systems. The burns were divided into two phases. The first test burns were conducted in October 1986 and examined different mixtures of chips and coal to determine their effect on steam production. We found that the boilers could replace up to 15 percent of the coal Btus without causing a significant derating of boiler capacity. The second phase scheduled for June 1-12, 1987, will examine the stack emissions to determine the effect that different chip/coal mixtures have on particulate and CO emissions. A report covering both phases of the test burns will be available from the Alaska Power Authority. *A.P. Richmond, A.F. Gasbarro, and G. Sampson.*

Older Forest Structure in the Rosie Creek Burn

A series of six stands of 2.47 acres each (hectare reference stands) were selected in and near the 1983 Rosie Creek Burn. Three stands were chosen to represent burned examples of the major mature upland forest types in the area: 1) white spruce old-growth, 2) mature aspen with aspen-white spruce inclusions, and 3) mature paper birch with a white spruce component. The other three stands are matched, unburned "controls." All but the burned aspen stand are located within the Bonanza Creek Experimental Forest. Documentation of each stand involves placing and tagging a permanent grid of metal posts, mapping the coordinate position of each woody stem greater than .75 inch, recording tree diameters, mapping fallen logs, and estimating snag heights. In 1986 fieldwork, all of the burned and unburned white spruce old-growth stands, half of the burned birch and unburned aspen stands, and one fourth of the unburned birch stand were completed. The burned aspen site was selected for sampling. An age sample of 102 tree discs was taken from a timber sale adjacent to the burned white spruce old-growth stand, and a similar sample of 24 trees came from the burned birch stand.

Basal area in one-sixteenth subdivisions of each stand in the unburned old-growth white spruce stand occupied a uniform .4 percent of plot surface; basal area averaged about .35 percent of plot in the burned stand. The highest basal area was .55 percent. The largest white spruce tree was 25 inches in diameter; the largest mean diameter was 13 inches. The unburned stand contained 642 white spruce trees (260 per acre); the burned stand had 423 (171 per acre).

Both stands are probably representative of best development of this forest type in interior Alaska. The age analysis revealed that all sample trees in the burned white spruce stand originated from a disturbance event (fire) about the year 1782. The last year of growth in the stand was 1982, supporting the generalization that the average fire return interval on upland white spruce sites is about 200 years. Three sets of distinct marker tree rings were discovered. One set marked an inferred snow or wind event in 1878 which profoundly depressed growth of the stand for two years and controlled the development of the modern structure of the stand. A 1910-12 marker ring sequence terminates in the year of the Katmai volcanic eruption. *G.P. Juday.*

The Effect of Burning on Phosphorus Sorption in the Rosie Creek Burn

Organic layers and surface mineral soils were collected from burned and unburned white spruce, black spruce, aspen, and birch sites within the Rosie Creek Fire. Visual analysis of the isotherms indicates that burning has no effect on phosphorus (P) sorption in mineral soils except for the aspen vegetation type. As expected burning does appear to have an effect on organic layers. All vegetation types showed an increase in P sorption after burning. *J. Yarie.*

Snowmelt Runoff for a Boreal Forest Watershed

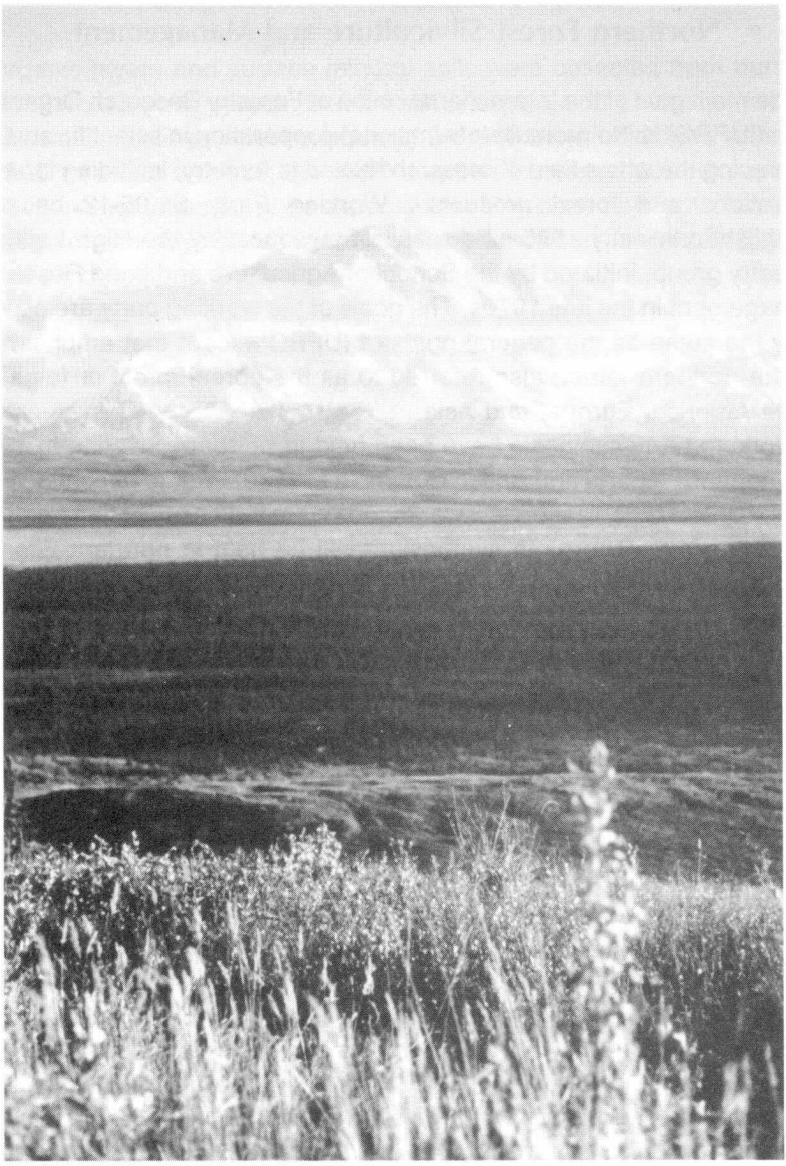
This is a new project designed to obtain reliable streamflow measurements from Spinach Creek during the spring breakup/snowmelt season, to estimate watershed snowmelt rates from streamflow measurements, and to test and modify, as warranted, the snowmelt algorithm of a watershed model currently being used to guide and assimilate research at the Spinach Creek watershed. The overall objective is to develop a tool useful in predicting the impacts of resource management activities on streamflow.

To date, good quality field data on streamflow have been collected for two snowmelt seasons. A new, daily, global radiation subroutine has been developed to facilitate improved estimates of snowmelt rates on different aspects. This subroutine is being tested against the historical data for the Fairbanks Airport and data from the UAF Geophysical Institute. Some of our first experiments with the snowmelt model will be a look at the effect of forest removal on snowmelt and runoff rates. Summaries of field data and simulation experiments should be valuable to Alaskan resources managers dealing with the interaction of resource development and hydrologic systems. The models developed may also provide a framework for incorporating and communicating knowledge of northern hydrologic processes. *J.D. Fox, Jr.*

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.

Working party symposia have been held in northern Sweden in 1985 and northern Alberta and British Columbia in 1986. Prior to becoming part of the IUFRO organization, six workshops were held as the High Latitude Forestry group. The ninth symposium will be held in northern Finland (Lapland) in 1987 with speakers from the United States, Canada, Norway, Sweden, Finland, Russia, and the Peoples' Republic of China. Proceedings have been published annually for the High Latitude Forestry Workshops and are in preparation for the two IUFRO symposia. *E.C. Packee.*



Resource management programs are essential to enhance the productivity of Alaska's lands as well as to protect such inherent values as scenic beauty. In Alaska, the prime resource benefits are often in the form of unique recreational opportunities or the simple enjoyment of the aesthetics of the natural landscape. (AFES staff photo)

Resource Management

Variety 'Nortran' Tufted Hairgrass Released To Serve Mining and Other Interests

Because of a perceived need for perennial grasses better adapted to our north latitude conditions than those commercially available for use, researchers at the Alaska Agricultural and Forestry Experiment Station have, throughout its history, shown an interest in the possible application of native grasses. The most recent manifestation of this interest is the release of the variety 'Nortran' tufted hairgrass *(Deschampsia caespitosa).* The new variety is recommended for revegetation use, for low-maintenance ground cover, and, under some circumstances, for forage or pasture use at northern latitudes. Nortran is believed to be the first cultivar developed of this grass species.

The development of Nortran tufted hairgrass was the result of cooperative efforts involving the Agricultural Research Institute of Iceland and AFES. An exchange of plant materials led to the testing of Icelandic collections of tufted hairgrass along with a number of Alaskan collections. This resulted in the inclusion of two Icelandic components with two Alaska components in the breeding material of Nortran. These two components are based on collections (a) from Galena on the Yukon River in western Alaska and (b) from the Talkeetna Mountains north of Palmer. Seed lots from the four components are combined to form the breeding generation of Nortran.

The components of Nortran have performed well in revegetation trials at strip mine sites in three coal fields from central interior to southcentral

Alaska. They also have shown promise in forage trials, and one component has persisted to form a dense turf in turf trials at Palmer.

Nortran hairgrass should be a good grass for use in reclamation seedings at coal mine, placer mine, and other construction sites in its region of application. If established in a thin stand on disturbed ground, it can reseed itself to help fill in open areas. The grass can provide an attractive, low-maintenance ground cover under infrequent mowing. Because of its tolerance to clipping, it lends itself to grazing use, though its value as animal feed has not been determined. In summary, Nortran is a multipurpose grass of north-latitude origin that should fill a variety of needs in Alaska. *Wm. W. Mitchell.*

Long-term Effects of Crude Oil Spills on Microbial Biomass and Activity in a Subarctic Soil

Numerous studies have been conducted on the short-term effects of crude oil spills in northern terrestrial ecosystems, but little is known about the long-term effects of such spills on soil microorganisms. In 1986, we began a study to determine the effects of ten-year-old oil spills on soil microbial biomass and activity in an interior Alaska black spruce forest. Winter and summer experimental hot crude oil spills were made at the site in 1976. Soil samples were collected from the oiled plots and from nearby unoiled plots on three dates during the 1986 growing season. Subsamples were incubated for one week at 50 degrees Fahrenheit and carbon dioxide (CO_2) evolution measured as an index of potential microbial activity. Adenosine triphosphate (ATP) content of the soils was measured as an index of microbial biomass. Hydrocarbon contents were measured for soils from the oiled plots. Samples were sent to the Palmer Analysis Laboratory for measurement of total carbon, total nitrogen, and other components. Decomposition rates of cellulose and wood were measured under field conditions by determining weight loss of filter paper squares and birchwood spatulas placed at different depths in the soil. Some of the filter paper squares and wooden spatulas were removed and weighed in 1986, others were left in the field for removal in 1987.

Reinvasion by plants into the oil plots was almost nil; some moss had crept into areas where the soil oil concentration was low. Average oil con-

tent in the surface horizon of the oil plots within 75 feet the spill points was about 25 percent. When calculated on a per-gram-of-soil basis, the average CO_2 evolution and the average ATP content of the unoiled plots was much higher than that of the oiled plots on all sampling dates. When calculated on the basis of unit of area, there was very little difference in the CO_2 evolution for the different treatments, whereas ATP content was considerably higher in the unoiled plots. Part of the higher ATP in the unoiled plots could be from plant roots. Carbon analyses have not yet been completed, but results indicate that the oiled soils contain enough decomposable organic matter to support an active population of microorganisms. Very little decomposition of the filter paper or wood occurred in the field during one growing season. *S.D. Sparrow and E.B. Sparrow.*

Arctophila Feasibility Project

Field investigations have focused on detailed sampling of the *Arctophila fulva* plant in a variety of habitats, laboratory analyses of materials collected during the 1985 field season, and initiation of studies of environmental factors at *Arctophila fulva* and non-*Arctophila fulva* sites in the Prudhoe Bay and adjacent oil fields. Temperature monitoring devices were installed, and aerial photographs were also obtained.

Because the work is closely related to current waterfowl studies in the vicinity, we received a special request for assistance in evaluating the nutritional value of *Arctophila fulva* and some plants associated with that grass relative to grazing geese. The only colony of snow geese nesting on the Arctic coast of Alaska raises its young on the brackish marshes and nearby plant communities on the east side of the Sagavanirktok River where it empties into the Beaufort Sea. The total land area grazed by the geese is relatively limited, amounting to perhaps less than 40 acres. The young birds grow rapidly there. It is difficult to explain the birds' rapid growth or to evaluate the habitat because little is known about the birds' diets, the productivity of the vegetation, or its nutritional value for grazers. We were asked to develop a technique that could be used to estimate the energy value of this forage for these geese.

It is known that food passage rates in the goose digestive system is rapid. Grass can pass through the goose gut in a little more than an hour according to laboratory experiments, indicating the wild goose is probably

digesting only the cell contents of plants eaten. Essentially, none of the structural components in plants consumed by the geese is digested. We had to find a method for measuring energy of the cell contents only in plants grazed by this snow goose colony. Because the cell content in plants is a mixture of solids and fluids, extracting and drying an uncontaminated sample from forage plants for energy analyses would be difficult and very time-consuming. We chose an indirect approach instead.

A combination of laboratory techniques and calculations was used, and reasonable data resulted. We collected several forages that the snow geese could be feeding upon near the mouth of the Sagavanirktok River. Gross energy of these forages was measured on portions of the samples. On other portions, a livestock forage evaluation technique was used to measure the amount of structural component in each collection and provide a sample of structural material for energy measurements. Caloric contents for the intact (digestible + indigestible) and the structural (indigestible) portions of these plants were measured. Using those data we were able to calculate the energy in the cell contents (digestible portion) and hence the digestible energy available to geese in these Arctic forages.

Average results from three common plant species indicate the birds would obtain a diet yielding more digestible energy if they selected the grasses *Puccinellia phryganodes* and *Arctophila fulva,* compared to feeding mostly on the sedge *Carex aquatilis.* The digestible energy available from leaves of these three plants was, respectively: 2195, 2056, and 1788 calories per gram dry matter. Based on these data, we expect a diet analysis for this snow goose colony will show a preponderance of grasses as opposed to sedges in the diet during the summer growth period, if geese select for digestible energy.

This technique is currently being used by the U.S. Fish and Wildlife Service to evaluate forage quality for geese nesting in the Yukon River Delta. *J.D. McKendrick.*

Characterization and Classification of Volcanic Ash Soils in Alaska

Soils derived from volcanic ash are extensive in southcentral Alaska, the Aleutian Islands, and portions of southwestern and southeastern

Alaska. A field study was conducted to examine the morphology of these volcanic ash soils, and samples were taken for laboratory analysis. This study is in cooperation with USDA-Soil Conservation Service, Forest Service, and Tohoku University in Japan. Alaska and Japan will provide the data base for the classification of cold Andisols. Many of those soils were previously classified as Spodosols, and a few are Inceptisols. The new laboratory and field data indicate that all of them meet the definition of either of the two suborders: Borands and Aquands. Further analysis of field and laboratory data available in both countries suggested that the proposed greatgroup in Circular 7 of the International Committee on the Classification of Andisols (ICOMAND) was in need of revision. The following great groups of Borands are proposed: Placoborands, Hydroborands, Alluborands, Melanoborands, Fulviborands, Vitriborands, and Haploborands. These soils are characterized by low bulk density, high phosphorus retention, and high content of amorphous aluminum or pyroclastic material. These properties were not used as differentia in the Spodosols but are important in land use interpretations. To date, twenty-two soil profiles from the Kenai Peninsula, Susitna Valley, Yentna, Kodiak Island, Sitka, and the Aleutian Islands have been studied. Their chemical, physical, and mineralogical properties were fully analyzed. The results were presented to the first International Soil Correlation meeting held in the Pacific Northwest in July 1986. The samples from another seven profiles from these areas are being analyzed.

The characterization and classification of these soils are important to farm management in relation to fertility and tillage, engineering interpretations for road building, cut and fills, on-site disposals, and mined land reclamation. *C.L. Ping.*

Economics of Agricultural Development

The changing environment of Alaskan agriculture has become the subject of recent public discussion and has led to a review of the present situation with suggestions for the future. The major land disposal programs for agriculture have ended, at least temporarily. The development thrust toward market penetration overseas has also been muted. Very little development is now occurring beyond the normal progress of the Pt.

MacKenzie project. Studies are underway to assess the benefits and costs of crop and livestock systems which are based on sales to domestic markets.

A study of the policy processes and measures of assistance to agriculture is continuing. Policy, assistance, and trade are closely interrelated for agriculture and agricultural development. It is clear that the measurement and comparison of rates of assistance to agriculture in different countries is becoming a significant issue in the way in which trade negotiations take place since agricultural trade has numerous mechanisms of domestic protection. Research is focusing on analysis of rates of assistance to agriculture using a spatial equilibrium model. This is a cooperative study with the University of New England, Armidale, N.S.W., Australia. *W.C. Thomas.*

Management Systems for Small-Grain and Livestock Production in Interior Alaska

Barley produced for grain is the primary crop in the Tanana Valley. Of the total 18,700 acres used for crops in the valley, 66 percent was used for barley. The total crop is sold in Alaska either directly to livestock producers or to manufacturers of various animal feed products.

Purchasers must be able to obtain barley at a competitive price while grain producers must be able to recover their costs if barley production is to continue. The Agricultural and Forestry Experiment Station has participated in obtaining production cost information from farmers in the Delta Agricultural Project, an 85,000-acre area used for barley production. Surveys distributed in 1983, 1984, and 1985 constitute a three-year effort to 1) collect costs of production for barley in interior Alaska, 2) determine equipment complements and management systems used, and 3) provide a historical record of production and production techniques.

Farmers were asked for information concerning production inputs; number of acres seeded and harvested; types and sizes of field equipment, grain dryers and storage facilities; and number, size, and type of buildings, as well as approximate yields. Production (variable) costs per acre were calculated from survey information as was the total investment

in equipment and buildings. Investment in land and land-clearing was obtained from state records.

Cash operating costs for production of barley in 1983 averaged $100.10 per acre, $96.68 per acre in 1984, and $117.91 per acre in 1985. The increase in cost in 1985 was attributable to an exceptionally rainy harvest season which increased drying cost in some cases by $16 per ton ($.80 per cwt). When the cash-overhead costs of repair, maintenance, and insurance were added, the total cash production costs were $117.35, $112.06, and $133.81 per acre, respectively, in 1983, 1984, and 1985. The average investment in equipment, grain dryers and storage, and buildings was $415,500. Complements were typical of those used in dryland grain-production regions elsewhere.

The average amount of land planted to barley over the three-year survey period was 828 acres. The range varied from a low of 320 acres to a high of 1540 acres. The average amount of land owned by farmers was 2600 acres. Land prices ranged from a low of $5.20 per acre paid in 1978 to a high of $218 per acre in 1981. The land had to be cleared of the native black spruce and moss cover before it could be used. Clearing costs varied from $150 per acre to a possible high of $300 per acre. Clearing has not been completed on all farms.

The yields obtained by farmers participating in the survey averaged 1680 pounds per acre in 1983, 1800 pounds per acre in 1984, and 1840 pounds per acre in 1985. The range, however, was very wide (from 520 pounds per acre to 3000 pounds per acre) during the three-year survey period. Best estimates in 1985 showed that purchasers of U.S. No. 2 barley could pay up to $120 per ton. This would have been sufficient to cover all cash costs of those barley producers in 1983 and 1984 who maintained yields at or over 2000 pounds per acre. In 1985, farmers would have to have maintained yields in excess of 2230 pounds per acre to cover all cash costs. *C.E. Lewis and E.L. Arobio.*

Modeling Production and Marketing Decisions for Alaska Reindeer Herds

The marketing of reindeer meat and by-products is facilitated by improving the information base. One area where current information is available

is from other countries where reindeer are produced. A survey was made of the Swedish reindeer industry to obtain information on slaughter techniques, meat processing, and general marketing conditions. A number of Swedish approaches to marketing have direct relevance to Alaska and have been suggested to the Alaska Reindeer Herders Association. Where applicable, this information will be modelled in the polyperiod linear programming model to estimate the potential differences between the present systems. *W.C. Thomas.*

Economics of Institutions Governing Private Land Use in Alaska

Work continued on the modelling of efficient time paths for public land disposal. Generalizations of previous work to include nonlinear demands for land, changing demand over time, cumulative costs of disposal, and/or time period disposal possibilities were accomplished. The comparative dynamics results demonstrate that, over a broad range of circumstances, the disposal problem reduces to single period optimization, particularly if the objective is to maximize the sum of discounted economic surplus. This is an important result from a practical point of view since it is generally much easier to solve a single period problem than a multiperiod one. There are cases, however, where a multiperiod time path for disposal is optimal. This outcome occurs with greater frequency when the assumed objective is the maximization of discounted net sales revenue. This latter objective may be a closer approximation to that of the state and boroughs in the current economic climate.

Work has been initiated in applying a hedonic price model to isolate the contribution of adjacent open space to residential property values. The study area will be a large subdivision in Fairbanks. Results of this study could hold implications for both taxing authorities and private land developers. *W.G. Workman.*

Recreation Management

In recreation management, one needs to understand the linkage between management programs and user response. This is even more true in Alaska where use is highly dispersed and not well understood. In managerial terms, this represents the dynamic equilibrium between supply and demand. This project has worked on developing the theoretical relationships between management and the user. This has led to the publication of one text book, two chapters in other books, and one journal article this past year. Even without empirical studies, management of recreational use can be improved by the understanding of the theoretical relationships.

Two empirical studies are near completion. One is on the development and testing of a new Recreation Opportunity Spectrum Model in the National Petroleum Reserve, Alaska. The model incorporates not only the biophysical inputs but also the managerially determined (through various management programs) attributes of the site (recreational opportunity). This is the first study to look at both sets of attributes using a multiplicative model. This is an outgrowth of some of the theoretical work. The other is a description of the Harding Icefield and the implication for management of the recreational use. Both are significant in that they incorporate the total set of possible management inputs into a decision-making framework. *A. Jubenville.*

Who's Planning Alaska: The Alaska Planning Directory

Since the 1970s the state of Alaska has been subdivided into hundreds of management units under the authority of a number of Federal, state, or local agencies as well as land-holding Native corporations. The Alaska Planning Directory, supported by the Cooperative Extension Service, is the primary source of information about these plans.

The directory is divided into four sections: Federal agencies, state agencies, local agencies, and Native corporations. Within each section all divisions that have land-planning obligations are listed. For each division the directory presents a brief history, the legal mandate for planning, the planning program, the process and participation methods used, the best con-

tacts, and the list of major plans (primarily those requiring public participation).

The directory was first published in draft form in 1985. Over five-hundred copies were distributed. A revised edition will be published in 1987 by the Cooperative Extension Service. Future updates are expected about every two years.

The directory provides basic information needed for a developing research project about the effects of land planning in Alaska. Particular subjects of analysis include: the cost and benefits of planning, problems of coordination across often complicated ownership boundaries, the ability of rural (and Native) people to participate effectively in the process, and the impact of planning on resource development. A "Delphi" type analysis of the problems and future of planning in Alaska, from the view of fifty planners, was recently completed. *T. Gallagher.*

The Colorado Joint Review Process: Application in Alaska

Alaska, like Colorado, has many large, proposed development projects, such as the Red Dog Mine, the Susitna Hydropower Project, and the Trans-Alaska Gas Line Project. These projects require numerous permits and other government licenses. The process of acquiring these approvals is arduous and often due more to procedural confusion than to problems with meeting permit requirements.

The State of Colorado responded to this situation with the Colorado Joint Review Process (CJRP), a "management overlay" to remove unnecessary organizational problems associated with permits. The CJRP was developed in the late 1970s and has been used on over twenty projects to date. The process does not alter agency responsibilities or other legal mandates. It is voluntary for both agencies and the project proponent.

With support from the UAF Faculty Small Grants Program, I interviewed some sixty people who have direct experience with CJRP. This group included almost-equal numbers of industry representatives, Federal agency staff, state agency staff, local government officials, consultants, and environmental group leaders. The results show strong overall agreement

that the CJRP increased coordination between permitting agencies and that it improved communication between the agencies and project proponent. All groups, except environmental group leaders, felt the process also improved public participation. With minor exceptions, all groups surveyed felt the process improved the amount of information and quality of alternatives used in making decisions, and most felt the process saved time and money. All groups, except some environmental group leaders, felt the state should retain the process, and even make it mandatory. Those environmental group leaders who did not support the process felt it worked too well, allowing some projects through that now were stopped by "red tape."

The CJRP may have substantial practical significance in Alaska. The state now provides permit coordinating services through its Office of Governmental Coordination, but does not have a specific procedure as formal as the CJRP. Given the strong industry and agency support for the CJRP process, the state may wish to consider augmenting its present program with a "joint review" process. *T. Gallagher.*

Arctic Land Planning: Time for Circumpolar Coordination

The Arctic over the past two decades has become a primary locus of development and planning. The implications of development and planning in the Arctic are, however, often widespread, crossing international and interdistrict boundaries as freely as Arctic caribou. Given the tremendous increase in resource development and the increased level of land planning by responsible agencies, there is a growing need for international communication and coordination.

To meet this need, planning activities in other countries are being studied. The intent of the study is threefold: (1) to develop an Arctic Land Planning Directory; (2) to establish a group, possibly an association, of planners and others interested; and (3) to develop coordination and communication links between group members so that each can share the in-

formation, alternatives, and procedures used by others for resource development or protection. *T. Gallagher.*

The Progress of Research Natural Areas In National Forest Planning

A national review was undertaken of the outcome of Research Natural Area (RNA) proposals in national forest land management plans as of mid-1986. Methods involved correspondence, a telephone poll, and collection of reports and publications. National forest planning has been conducted according to national standards given in the National Forest Management Act. The implementing regulations require the development of detailed lists of RNA needs by each of the nine Forest Service Regions. The lists include plant communities, rare plants and animals, and geologic and aquatic features. However, new RNAs are selected and proposed on a national forest basis, and a national perspective of the outcome of RNAs in forest plans has been lacking.

As of mid-1986 there were 150 established Forest Service RNAs. National forest plans propose a minimum of 550 new RNAs; the maximum option of plans would result in over 612 new RNAs. This would represent an overwhelming increase in the size of the RNA network; RNAs would become a major use of the national forest system. This result came about without major public controversy. Typically, new RNA proposals came from a diverse set of Forest Service cooperators at universities, the Nature Conservancy, and Forest Service managers and scientists. The decisive factors in getting RNA proposals accepted have been 1) expertise on the location and relative abundance of rare plants and animals, 2) good knowledge of the planning process and timely participation in it, 3) the availability of comprehensive plant community classification systems, 4) persistence by dedicated RNA advocates within the Forest Service, and 5) a high degree of cooperation and information sharing. A highlight has been the operation of several active Regional RNA committees with the invited participation of people from many different agencies and backgrounds.

A detailed Establishment Record is required before new RNAs are established; only 117 Establishment Records for the proposed new RNAs

have been completed or largely completed. A substantial backlog obviously exists, and new resources will be needed to deal with it. The Forest Service is shifting from a 10-year period of intensive planning activity to a period of implementing national forest plans. Even allowing for the RNA backlog, establishment and management of new RNAs may be the most advanced item in implementation of forest plans.

The Pacific Northwest Region has the most mature RNA program, with extensive monitoring and research underway in many existing and proposed new RNAs. The Alaska Region will contain RNAs unique in the national forest system because of their inclusion of glaciers and coastal marine features. *G.P. Juday.*

Forest Reference Stand Monitoring In Alaska Research Natural Areas

Data from the initial measurement of forest reference monitoring plots established between 1979 and 1986 in proposed or established Alaska Research Natural Areas (RNA) were compiled and analyzed. Reference stands in interior Alaska RNAs are 2.47 acres in size (hectare reference stands) and are further subdivided into plots one-sixteenth that size, or 82 by 82 feet. In coastal Alaska RNAs, plots are either that size or 164 by 164 feet (one-fourth of a reference stand).

There are twenty plots in interior forests. Sixteen plots are in mature white spruce *(Picea glauca)* stands, including one set of two and one set of four contiguous plots. The largest white spruce tree was 23.6 inches in diameter, the highest basal area was 187 square feet per acre. Typical tree stocking levels (all species) were 280 to 360 trees per acre. Only three plots are in mature paper birch *(Betula papyrifera)* stands, where stocking levels are 600 to 800 trees per acre. One plot represents a treeline stand where wind-deformed, ground-hugging white spruce have assumed tree stature within the past two or three decades.

Eleven stands were sampled in coastal Alaska: three in the southeast and eight in the southcentral regions of the state. The Red River RNA plot in southernmost southeast Alaska supports four conifers: Pacific silver fir *(Abies amabalis),* western hemlock *(Tsuga heterophylla),* sitka spruce *(Picea sitchensis),* and western red cedar *(Thuja plicata).* Mountain hemlock

(Tsuga mertensiana) and shore pine *(Pinus contorta)* occur in the immediate vicinity, and two other conifers probably occur in the area, making the Red River area the richest in conifer species of any area in Alaska. The old-growth Red River plot is particularly densely stocked; it supports substantially more than 400 trees per acre because of the codominance of two very tolerant species, silver fir and western hemlock. Old-growth mountain hemlock-sitka spruce plots at Green Island (outer Prince William Sound) and Granite Cove (near Columbia Glacier) support about 305 square feet per acre stand basal area. The mean diameter of sitka spruce on all plots was 9.8 inches. *G.P. Juday.*

Plant Species Range Extensions from Alaska Research Natural Areas

In cooperation with the UAF Herbarium, the records of vascular plant species collections from twenty-eight proposed or established Research Natural Areas (RNAs) in southeast, southcentral, and interior Alaska and the Seward Peninsula have been compiled and researched. Twenty of the RNAs support populations of plants growing significantly beyond their previously known distribution in Alaska. New plant distribution records per site ranged from a high of eighteen at Camp Haven Gap on the Seward Peninsula to one at Mount Prindle. A total of forty-eight significant range extensions and four marginal extensions occurred on nineteen sites not including Camp Haven Gap. By comparison, the flora of Alaska includes approximately 1,500 vascular species, the great majority of which are common, widespread, and well known in distribution.

In the past a determined search in nearly any poorly collected portion of Alaska yielded new range extensions. This is generally true, although to a lesser degree, today. Western and southwestern Alaska remain in the least well collected parts of the state and have produced the most impressive lists of new collections in sheer number as well as in distance from the nearest previously known collection point. Only a few of the RNA collection projects took place there. An ample amount of work on the distribution of Alaska's flora remains to be done. But the pace of new discovery continues to slacken.

Unlike broad-scale plant collection efforts in uncollected regions of Alaska during the 1960s and '70s, the RNA collections have been associated with very specific tracts, many with rare geological features or habitat conditions. RNA projects at hot springs and the outer coastal fringe of Prince William Sound have also yielded major extensions (in distance) of previous records. *G.P. Juday.*

Documentation of Proposed Research Natural Areas Of the Western Tanana Valley State Forest

Two of the six proposed Research Natural Areas (RNAs) in the Tanana Valley State Forest (TVSF), Oblique Lake and Caribou Crossing, were visited in the 1986 field season. Both areas are located in the western portion of TVSF near the confluence of the Kantishna and Tanana Rivers.

The Oblique Lake RNA was selected to include contrasting aquatic systems. Oblique Lake occupies a trough oriented in a direction crossing (oblique to) the axis of several parabola and linear dunes in the area. Oblique Lake is about 300 acres in size with a measured maximum depth of 34 feet. The RNA also includes an unnamed oxbow lake on the Kantishna River floodplain. Both lakes support rich submerged and emergent vascular plant beds. A pond weed *(Potamogeton epihydrus)* was collected at Oblique Lake which was known previously from the Kenai Peninsula, southernmost southeast Alaska and two locations in the Interior. A pair of trumpeter swans *(Olor buccinator)* nested at Oblique Lake in 1986. Reference forest plots were established in two paper birch *(Betula papyrifera)* stands which are representative of the great expanse of hardwood forest covering the higher dunes. The birch originated from a fire over 80 years ago. Small pockets of white spruce (Picea glauca) old-growth growing on sandy soils survive in ravines. Steep, dry sand bluffs support a pumpelly bromegrass *(Bromus pumpellianus)* prairie which is extensively reworked by large ant colonies.

The proposed Caribou Crossing RNA includes three basic units: 1) an old-growth white spruce forest on deep productive soils on a slope above the Tanana River; 2) a bottomland unit including sedge marsh wetlands, willow stands, and small pockets of productive white spruce forest; and 3) a hill prairie on steep slopes within soils. The upland white spruce forest

is part of one of the largest expanses of well-stocked old-growth productive upland conifer forest in interior Alaska. About 1,500 acres of the type are in the RNA. Habitat for snag- and cavity-nesting birds and flying squirrel *(Glaucomys sabrinus)* is excellent. Two reference forest plots were established in the upland white spruce type. The Tanana River bottomland is a mosaic of wetland sedge *(Carex)* marsh, successional shrub stands heavily used by moose *(Alces alces),* productive mature white spruce forest, and declining birch-white spruce forest with cold soils. Reference forest plots were established in mature white spruce and declining birch-white spruce stands. The hill prairie occupies steep slopes in the western portion of the area. A new location for the dry-site Ross's sedge *(Carex rossii)* was discovered on the prairie. *G.P. Juday.*

Documentation of Research Natural Areas On the Chugach National Forest

Three of the nine Research Natural Areas (RNAs) approved by the Chugach National Forest Land and Resource Management Plan were visited and documented in the summer of 1986. Green Island is located in outer Prince William Sound just north of Montague Island. The Green Island RNA includes: 1) the watershed crest and south-facing slopes of Green Island, 2) all 46 acres of Little Green Island, and 3) the Needle, an isolated rock jutting above high tide line. Green Island supports forest sites that are among the most productive in the Chugach National Forest. These highly productive sites are restricted to isolated pockets of highly unstable soil which is churned and mixed by downslope movement. Western hemlock *(Tsuga heterophylla)* and sitka spruce *(Picea sitchensis)* are the principal dominant trees on productive sites. Unstable bluffs behind the beach are so active that few trees reach great age or size. Stable sites undergo a conversion to peaty acidic wetlands supporting open mountain hemlock *(Tsuga mertensiana)* woodland or no trees. Little Green Island supports a 5-acre patch with probably the largest trees (sitka spruce) on the Chugach National Forest.

Gabbroic sills (volcanic rock injected into layers) run parallel to the northeast-southwest axis of Green Island. At points where gabbro extends

into the intertidal zone it forms rocky headlands especially rich in marine invertebrates and algae (kelp forests). The kelp forests and offshore waters support a large population of sea otters *(Enhydra lutris);* Green Island supports one of the few populations of sea otters which survived the intensive slaughter of the nineteenth century fur trade. The Needle is a sea lion *(Eumetopias jubata)* hauling-out ground; it also supports colonial-nesting sea birds.

Copper Sands RNA is a shifting, emerging sandy barrier island off the mouth of the Copper River Delta. Probably no portion of the area stood above the tideline before the great 1964 earthquake uplift. The highest and largest stable surface is located in the southern portion of the area along a main distributary channel (the principal source of sediment) of the Copper River. A windswept deflation plain behind the main stable surface is a major molting area for semiflightless dusky Canada geese *(Branta canadensis occidentalis)* and glaucous-winged gulls *(Larus glaucescens).* A few brown bears have apparently learned of the availability of this new prey base and are actively preying on the immature gulls. The other stable surface is still actively emerging in the northern portion of the RNA. Along a network of monitoring transects on these emerging "knobs" one to two feet of sand were deposited between mid-June and mid-August 1986.

Schwan Glacier Terminus RNA is located in the 1980 addition to the Chugach National Forest east of Valdez. The RNA occupies 12,160 acres, of which 4,382 acres are glacial ice. It contains no commercial timber. The RNA includes the terminus of a major trunk valley glacier (Schwan), its proglacial lake and outlet stream, and two complete small alpine valley glaciers which have been steadily receding at least since 1950. A series of metal posts were placed in a survey along the front of the eastern alpine glacier in mid-August. Further recession can be marked from this transect. The Schwan Glacier RNA supports mountain goats and brown bears. The goats utilize intensively the restricted number of ledges and shelves with a southern exposure. Brown bears forage for roots and tubers of preferred food plants in subalpine meadows above the Tasnuna River Valley. Previous advances of Schwan Glacier have left a series of fresh moraines on the Tasnuna lowlands. These morainal surfaces are covered by alder jungle, young black cottonwood *(Populus trichocarpa)* forest, and lush lichen-moss mats on sterile gravel pavements. Two forest plots were established, one on a young and the other on an older morainal ridge. Black cottonwood trees on the young ridge ranged in age from 25 to 40

years; on the older ridge they were from 70 to 90 years old. Only one conifer seedling, white spruce *(Picea glauca),* was seen in the entire area. *G.P. Juday.*

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Theses and Dissertations

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GORDON, A.M. 1986. Seasonal patterns of nitrogen mineralization and nitrification following harvesting in the white spruce forests of interior Alaska. Ph.D. Dissertation. University of Alaska-Fairbanks.

HEFFERNAN, T.T. 1986. Height growth of *Larix laricina* (Du Roi) K. Koch on a variety of sites in interior Alaska. Masters Thesis. University of Alaska-Fairbanks.

HOM, J.L. 1986. Investigations into some of the major controls on the productivity of a black spruce *(Picea mariana* [Mill.] B.S.P.) forest ecosystem in the interior of Alaska. Ph.D. Dissertation. University of Alaska-Fairbanks.

JORGENSON, M.T. 1986. Biophysical factors influencing the geographic variability of soil heat flux near Toolik Lake, Alaska: Implications for terrain sensitivity. Masters Thesis. University of Alaska-Fairbanks.

MCINTYRE, H.H. 1986. Horticulture uses of an Alaskan peat. Masters Thesis. University of Alaska-Fairbanks.

O'SULLIVAN, K. 1986. The effects of vegetation and slope on trail erosion in the Yukon-Tanana uplands of interior Alaska. Masters Thesis. University of Alaska-Fairbanks.

WESTENBURG, D.L. 1986. Recreational users management preferences for the Kenai River, Alaska. Masters Thesis. University of Alaska-Fairbanks.

Financial Statement

Expenditures — July 1985-June 1986

Statement of expenditures of federal and state funds for the fiscal year beginning July 1, 1985, and ending June 30, 1986.

		% of total
Federal		
Hatch Regular Formula Funds	$ 574,705	8.6
Hatch Regional Formula Funds	105,762	1.6
USDA-Agricultural Research Service	231,604	3.5
McIntire-Stennis Formula Funds	178,361	2.7
Other Grants and Contracts	1,404,650	21.1
State Funds	4,155,880	62.5
Total	$6,650,962	100.0

University of Alaska – 1986

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Director, Instruction and Public Service, School of Agriculture and Land Resources Management: Bonita J. Neiland
Assistant Director, Agricultural and Forestry Experiment Station: Sigmund H. Restad

Professional Staff

LEE D. ALLEN, Associate Professor of Agricultural Engineering; University of Idaho '57, B.S., '72, M.S. Mr. Allen's agricultural engineering research has included insulation and vapor barriers, cold-climate animal environment and waste disposal, soil cement and rammed earth structures, grain and hay drying, northern climatic measurements and phenology, irrigation and tillage, locally grown vegetable processing, and preservative treatment of Alaskan woods. Mr. Allen joined the AFES staff in 1957. He has been Alaska's representative on ten midwest and western Regional Research Committees. Mr. Allen retired in January.

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 cut roses and such investigations as the feasibility of small-scale meat production of ducks, geese, and rabbits in a village setting for sale in Alaska markets. 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 working on applying newly developed computer software to various farm management systems 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 1971, 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.

DONALD E. CARLING, Assistant 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 ultrastruc-

tural 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 studies of herbicides, seed treatments, and general cultural practices. Applied research with vegetables includes variety trials, nitrogen fertilization studies, and transplant evaluation. More basic research includes the study of root disease of potatoes and vegetables caused by the soil-borne fungus *Rhizoctonia solani*.

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 19 years with USDA Agricultural Research Service at Pullman, Washington. His work with AFES is on crop residue management in reduced tillage for interior Alaska.

WILLIAM B. COLLINS, Assistant Professor of Range Management; Brigham Young University '74, B.S.; Utah State University '77, M.S., '79, Ph.D. Dr. Collins's research interests are: behavior of grazing animals, grazing systems, and range management, with emphasis on reindeer production. Dr. Collins has also worked on problems associated with range use by mule deer, elk, pronghorn antelope, moose, musk ox, wild horses and burros, cattle, and domestic goats.

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 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.

ROBERT A. DIETERICH, 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 Agriculture 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.

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 resource 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 is currently conducting research on natural resource policy, is coordinator of UAF's applied reindeer research and instruction program, and teaches an upper division course on the Alaska reindeer industry. He was recently appointed to the National Public Lands Advisory Council by Secretary of the Interior Donald Hodel.

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 the University of Alaska 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. His research interests are in the area of planning processes, participation methods, and rural land planning. He is presently conducting research on use of the Colorado Joint Review Process, a method of coordinating the permitting of large development projects, in Alaska. 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.

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 5 years with the US Forest Service both in California and Alaska, 2 years with the Peace Corps in the Dominican Republic, and 2½ 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. He is principal investigator of the Intensive Forest Management Program and currently holds a joint appointment between SALRM and the Cooperative Extension Service.

MARILYN GRIFFITH, Assistant Professor of Plant Physiology; Mt. Holyoke College '75, B.A.; Yale School of Forestry '77, M.F.S.; University of Minnesota '81, Ph.D. Dr. Griffith was awarded a Killam Fellowship in 1981 to pursue independent research at the universities of British Columbia and Western Ontario in Canada. Her research interests are focused on growth and development of plants at low temperature using expertise in physiology, biochemistry, and anatomy. Since joining AFES in 1984, Dr. Griffith has been involved in directing research programs in plant physiology and horticulture.

CHARLES W. HARTMAN, Executive Officer; Rutgers University '64, B.S.; University of Alaska '67, M.S. Mr. Hartman worked as a research engineer/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 background includes soil-vegetation relationships around alpine snowfields and vegetation inventory techniques in Colorado. She is helping to streamline data collection and report generation techniques using available microcomputers and university mainframe computers. She has also taught a range management course at the Matanuska-Susitna Community College.

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 in 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 the lingonberry. She joined SALRM in 1984 and teaches courses in plant propagation, general horticulture, vegetable crops, and greenhouse crops production. 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 waste 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, and nutrition and metabolism for undergraduates and graduates through the Natural Resources Management degree 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 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 received a Meritorious Service Award for natural areas work from the governor of Oregon. He 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 in Alaska 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 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 is 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 as concerned with germplasm modification within introduced populations during natural selection toward subarctic adaptation.

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, Visiting Assistant Professor of Mycology; Western Washington State University, Bellingham '65, B.A., B.S.; University of Montana, Missoula '70, M.S.; 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, and Switzerland. Dr. Laursen's current interests emphasize Arctic Alaska fungal ecology 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 ef-

forts 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 the 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 '74, 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.

WILLIAM W. MITCHELL, Professor of Agronomy; University of Montana '57, B.A., '58, M.A.; Iowa State University '62, Ph.D. Dr. Mitchell's background of research is with grasses in natural ecosystems, with particular respect to ecotypical adaptation and teaching in biological sciences. He joined AFES in 1963 where he com-

menced studies on native grasses of Alaska, investigating the taxonomy, distribution, adaptation, and cytological races of selected species. Dr. Mitchell conducted revegetation research in the Prudhoe Bay oil field, along the trans-Alaska pipeline route, and on Amchitka Island, leading to the release of native grass varieties for revegetation use. He is currently studying revegetation of surface-mined lands in interior and southcentral Alaska. His major activities now include research on application and management of grasses for forage uses in a number of agricultural areas in the state and turf studies at the Palmer Research Center.

MAYO MURRAY, Publications Supervisor and Public Information Officer, SALRM, attended the University of Connecticut and the University of Alaska. Mrs. Murray has been with the University of Alaska since 1972 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. Murray provides information to many agencies and publics.

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 has been head of the Department of Land Resources and Agricultural Sciences at UAF. In 1952, she was a Fulbright Fellow to the University of Wales.

EDMOND C. PACKEE, Assistant Professor of Forest Management; University of Montana '62, B.S., Yale University '63, M.S., University of Minnesota '76, Ph.D. Dr. Packee's research background is in the coniferous forests of the Pacific Slope north of the redwoods, the Rocky Mountains, and interior Alaska as well as in the northern hardwood forests of the Great Lakes states. He also has forest management experience in northern Wisconsin and coastal British Columbia. He was senior silviculturist for 15 years with a forest products company in 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 technical advisor to the Governor's Timber Task Force. 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 is working primarily with conservation tillage systems and fertilizer management in research plots established in the Delta 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.

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. His present position includes 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 4 years as an officer in the United States Army, Mr. Richmond left the service to attend the University of Alaska. He has worked since 1979 in the Intensive Forest Management Program, demonstrating and evaluating various pieces of forestry equipment and silvicultural practices which may improve the productivity of in terior Alaska's forest lands. Research has been directed toward determining forest management options available to forest managers.

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 3 years and an instructor of agriculture and natural resources management at Colorado Mountain College for 2 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, PhD. Dr. Sparrow's research experience is in soil and environmental microbiology and plant-soil relationships. She has worked for the International Rice Research Institute, Depts. 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 1973-1977, 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. Current research emphasis is 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.

WAYNE C. THOMAS, Professor of Economics; California State Polytechnic University '65, B.S.; University of Nevada '67, M.S.; Washington State University '71, Ph.D. Dr. Thomas's academic background is in agricultural economics. Since joining the University of Alaska-Fairbanks faculty in 1971, he has conducted research into land management issues, the economics of Alaskan agriculture including reindeer, and the role of government in the agricultural development process. Dr. Thomas has participated in research activities supported by the United Nations and was named a Senior Fulbright Scholar to Australia in 1980. He was appointed Acting Director of Graduate Studies in September of 1986.

KEITH VAN CLEVE, Professor of Forestry (Soils); University of Washington '58, B.S.; University of California, Berkeley '60, M.S.; University of California, Berkeley '67, Ph.D. Dr. Van Cleve 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. 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 26-month term as Head, Department of Biology, Fisheries, and Wildlife in May 1986.

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 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 coordinator of the M.S. program in Resource Economics in the School of Management.

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

1986 Annual Report

Editor ..... Mayo Murray
Composition ..... Tobi Campanella
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