Agroborealis

Volume 6, Number 1; May/1974

Institute of Agricultural Sciences
University of Alaska

A Review of Some Research in Progress

From The Director's Desk

Alaskan agriculture is facing a grave crisis. There is a strong possibility that its development may be cut short before it has a fair chance to get started.

On the bright side, the future of agriculture in Alaska has never seemed more promising. Overnight the nation's surpluses have disappeared and food prices have been gaining on production costs so rapidly that certain farm enterprises, which until very recently would have lost money here, have suddenly become profitable. Moreover, a careful re-examination of Alaska's land resources has disclosed the startling fact that Alaska ranks among the major farming states in agricultural potential. A new soil survey has revealed five times as much tillable land as we thought we had. In fact, it appears that Alaska's potential agricultural land exceeds that of the state of Iowa, and the latest yield data reveal that, for adapted crops, the productive capacity of our land, per acre, compares favorably with that of any other state. At today's prices, Alaska could produce over $1.5 billion worth of grain a year, every year — long after the last drop of oil is gone. If converted into beef, Alaska's grain and grasses could produce over one-tenth of all the meat now being consumed by the entire United States.

The bad news is that almost all of Alaska's potential agricultural land has just been taken out of circulation, perhaps permanently. After 350 years of conquering the wilderness, subduing wildlife, taming rivers, tearing up the land and paving it over, many Americans have finally come to realize that at this rate, their natural environment will have been completely destroyed within a very few more years. In response to popular feeling and in compliance with a congressional directive, the Secretary of the Interior has nominated over 80 million acres of Alaskan land for possible inclusion within the national system of parks, forests, wildlife refuges, wilderness areas, and wild rivers. In addition, he has also withdrawn from entry all remaining unappropriated public lands in Alaska. Unfortunately, almost all suitable land and certainly our best agricultural land is included in these massive withdrawals.

Few Alaskans would quarrel with the aims of the conservation movement, or even with the idea of preserving large areas of the state in their native wild condition. After all, most of us are here precisely because we have elected to spend our everyday lives, and not just our vacations, in an unspoiled natural environment. And of course farmers, more than any other group of similar size, have deliberately chosen to live in harmony with nature.

The final decision will be up to the people, and we hope that they can be brought to understand soon enough that the supply of agricultural land is not unlimited and that, since they are going to have to share their food with a crowded world, it is high time to start conserving this most precious of all natural resources. Surely, from Alaska's 375,296,000 acres, it should be possible to select 80 million for preservation without seriously encroaching on the mere 4% that have agricultural value!

What does appall agriculturally minded Alaskans, however, is that the readily available results of almost 80 years of government and university research and close to 180 years of practical farming experience in Alaska have been virtually ignored in the impact statements prepared by the Interior Department. In fact, one gathers from these statements that, due to the poor soils and harsh climate of Alaska, the agricultural potential of all of these lands is low or nonexistent. This is merely telling the public what it thinks it already knows. It certainly does not represent the considered judgment of objective scientists.

Agroborealis

MAY/1974

Volume 6 Number 1

Agroborealis is published by the **University of Alaska Institute of Agricultural Sciences**, Fairbanks, Alaska 99701. A written request will include you on the mailing list. Institute publications are available to all persons, regardless of race, color, or national origin.

To simplify terminology, trade names of products or equipment may have been used in this publication. No endorsement of products or firms mentioned is intended, nor is criticism implied of those not mentioned.

TABLE OF CONTENTS

Silage –*Page 11*

Sweet Corn –*Page 31*

Agronomists –*Page 33*

Agroborealis is published under the leadership of the IAS Publications Committee: A.L. Brundage, Chairman: L.J. Klebesadel; C.E. Logsdon; W.C. Thomas; and F.J. Wooding.

Consulting Editor Mary C. Langan
Managing Editor A.L. Brundage

Printed by Northern Printing Co., Inc.

ABOUT THE COVER . . .

Caribou show appreciation for revegetation research on the North Slope. Cover photo shows five bulls grazing grasses seeded by Instutite of Agricultural Sciences researchers in plots over a buried natural gas test pipe at Prudhoe Bay. See page 33 for further details. Photo by W. W. Mitchell.

Figure 1. Middle Kuskokwim River area.

Figure 2. Viewing the test plots of barley in the foreground and oats in the background were George Willis (left), extension agent Dave Hassinger (center), and extension trainee Fred Vaska (right).

Grains In Seward's Icebox

FRANK J. WOODING
Assistant Professor, Agronomy

DAVID H. HASSINGER
Cooperative Extension Service Agent, Aniak

GEORGE WILLIS
Cooperator, Red Devil

Grow grain along the Kuskokwim? George Willis thought it could be done. He tried it and was successful!

To those who are not completely familiar with the climate and soils of western Alaska, these statements might appear to be lacking in credibility. For years, many have considered the Kuskokwim River area too cold to support agricultural crops. It is still sometimes referred to as "Seward's Icebox," the old expression frequently applied to Alaska during the years after Secretary of State Seward negotiated the 1867 purchase of the territory from Russia.

The George Willis family lives in western Alaska near the small village of Red Devil. Their home is located along the Kuskokwim about eight miles downriver from Sleetmute and 110 miles upriver from Aniak (Figure 1). During the summer of 1972, Willis contacted Cooperative Extension Service agent Dave Hassinger of Aniak about the possibility of growing grain crops on his place for use as food and feed. He had cleared several acres of birch-spruce forest land, part of which was planted to a home garden. Willis was interested in what types of grains might be grown under the soil and climatic conditions prevailing at Red Devil and expressed a willingness to cooperate in conducting test-plot work. His inquiry was forwarded to the Institute of Agricultural Sciences, Fairbanks.

Due to logistics and the remoteness of the area, virtually no research information pertaining to crop production was available. However, long-term weather records from Aniak provided some indication of the type of growing season that might be expected at Red Devil.

A cooperative study was arranged between Willis, the Extension Service and the Institute. It was decided to conduct a "Preliminary Adaptation Test" for small grains. The test consist-ed of single-row plantings of 50 varieties of barley, oats, wheat, rye and triticale. Both winter and spring varieties of each grain type were selected; maturity ranged from early to late.

The purpose of this study was to determine the grain types and the varieties within grain types which will grow to maturity, and to obtain an estimate of the productivity at this location. These data provide a rough idea of what there is to work with and a starting point for more refined research.

Lime, fertilizer, pre-measured packets of seed, and instructions for establishing the test plots and recording the data were assembled in Fairbanks. The materials were mailed to Dave Hassinger in Aniak who in turn transported them upriver by boat to the Willis place. The winter grains were planted on August 5, 1972 and the spring grains on May 28, 1973. George Willis kept records of winter survival, flowering dates, maturity dates, growth, and lodging. Hassinger made periodic inspections of the grains and maintained contact with Fairbanks by letter and phone.

In early August of 1973, the senior author observed and evaluated the test plots. At that time, all of the grains were fully headed and some of the early-maturing barley and oat varieties were beginning to fill out (Figure 2). All the grains had produced good growth and tillering. The most impressive growth was obtained from rye which towered head-high (Figure 3).

In the fall, grain heads were clipped from each plot, packaged, and shipped to Fairbanks for threshing and yield estimation. Results of the study are presented in Table 1. Each variety was given an adaptation rating ranging in value from 1 to 5 with "1" representing the best adapted and "5" the poorest. Evaluation was based primarily on yield and the ability of the variety to mature, with maturity carrying the most weight. To receive a value of "1", the variety had to ripen fully and produce a respectable yield. Varieties that ripened fully but were low-yielding, or varieties that produced respectable yields but did not ripen fully (straw remained partly green) were classified as "2" or "3". Varieties rated "4" generally had both yield and maturity deficiencies. Varieties that did not produce mature seed were designated as "5".

Oats performed best, producing yields ranging from 71 to 108 bushels per acre. Most of the oat and approximately half the barley varieties ripened fully. All winter wheats and the one winter rye included in the test produced mature seed, but the straw remained partly green at the termination of the growing season. Low yields obtained on some of the varieties reflected poor winter survival. Spring wheat, spring rye, and triticale did not produce mature seed. These grains were not at a sufficiently-advanced stage of development to withstand the damaging effects of a frost on August 14.

Growing seasons may differ substantially from year to year and a single

TABLE 1

Results of a small grain preliminary adaptation test conducted on the George Willis Place, Red Devil, Alaska, 1972-1973.

Grain Type	Variety	Growth habit	Grain yield bu/A	Adaptation rating
Oats	Pendek	Spring	108	1
Oats	Nip	Spring	108	1
Oats	Toral	Spring	104	1
Oats	Golden Rain	Spring	99	2
Oats	Harmon	Spring	90	3
Oats	Random	Spring	84	4
Oats	Rodney	Spring	82	3
Oats	Cayuse	Spring	75	1
Oats	Ceal	Spring	71	1
Barley	Dicktoo	Winter	31	1
Barley	W6544	Winter	17	3
Barley	Kearney	Winter	8	4
Barley	Lidal	Spring	32	1
Barley	Edda	Spring	23	2
Barley	Olli	Spring	16	2
Barley	Gateway 63	Spring	16	2
Barley	Galt	Spring	14	4
Barley	Weal	Spring	12	4
Barley	Cree	Spring	10	4
Barley	Jubilee	Spring	8	4
Wheat	Cheyenne	Winter	30	2
Wheat	Trapper	Winter	24	2
Wheat	Lancer	Winter	19	3
Wheat	Froid	Winter	18	3
Wheat	Trader	Winter	15	3
Wheat	NB66403	Winter	13	3
Wheat	Shoshoni	Winter	12	3
Wheat	Winalta	Winter	11	4
Wheat	Omaha	Winter	7	4
Wheat	Scout 66	Winter	3	5
Wheat	Warrior	Winter	2	5
Wheat	Sawmont	Winter	2	5
Wheat	Gasser	Spring	*	5
Wheat	Thatcher	Spring	*	5
Wheat	Park	Spring	*	5
Wheat	Canthatch	Spring	*	5
Wheat	Saunders	Spring	*	5
Wheat	Manitou	Spring	*	5
Wheat	Pitic	Spring	*	5
Wheat	Garnet	Spring	*	5
Rye	Saskatoon	Winter	17	3
Rye	Prolific	Spring	*	5
Rye	Karshulder	Spring	*	5
Rye	Petkuser	Spring	*	5
Triticale	6TA131	Winter	*	5
Triticale	6TA518	Spring	*	5
Triticale	6TA419	Spring	*	5
Triticale	6TA208	Spring	*	5
Triticale	HN470	Spring	*	5
Triticale	Rosner	Spring	*	5

*Mature seed was not produced

Figure 3. Rye towered head-high.

year's data may be misleading. A test of this nature is more meaningful when conducted over a period of 3-5 years. However, in view of the earlier-than-normal frost, which shortened the growing season, those varieties receiving an adaptation rating of "1" would likely perform well over a period of years.

The test plots on the Willis place may be a first for grains in the middle Kuskokwim area, but other forms of agriculture have existed for many years. Potatoes, carrots, cabbage, peas, and other vegetables thrive in home gardens at village sites such as Little Russian Mission (Figure 4), Crooked Creek, and Napamute. Berries also grow in the wild and in home gardens. Several greenhouses in Aniak successfully grow tomatoes, cucumbers, and other warm season crops.

Portions of the Kuskokwim, like many other remote areas of Alaska, have considerable potential for agriculture, but the scope of this potential is virtually unknown. Soils and climatic conditions are suitable for production of small grains, forages, berries, and many types of vegetables. There is much to be learned, and studies such as those conducted at Red Devil represent a step in the right direction. □

Figure 4. Garden site along the Kuskokwim River near Little Russian Mission.

An Examination Of The Salad Vegetable Market Of Anchorage And The Kenai Peninsula, Alaska

WILLIAM G. WORKMAN
Assistant Professor, Economics

and

CHARLES F. MARSH
Research Economist

The former Wildwood Air Force Base at Kenai, Alaska, now the property of the Kenai Native Association, is the site of a research project in controlled environment agriculture (CEA). The University of Alaska, the U. S. Department of Agriculture, General Electric Corporation, and the Kenai Native Association are cooperating to investigate the economic feasibility of producing salad vegetables under controlled environmental conditions. Plant responses to varying levels and combinations of environmental factors will be examined in experimental modules and pilot-plant operations. Both physical response and cost data will be generated to determine conditions for economic optima.

For successful commercial adaptation, this method of vegetable production must be competitive with current sources (suppliers) of salad vegetables to the local market. Therefore, the initial effort of the economic research was to determine some of the characteristics of the current salad vegetable market in the greater Anchorage and Kenai Peninsula areas. Specifically, the objectives of this market study were (a) to determine the principal types and varieties of salad vegetables now marketed there and (b) to determine the quantity and value of salad vegetables being sold. The results of this inquiry are reported here.

Procedure

Most salad vegetables marketed in Alaska are grown in the following areas: The Imperial and Salinas Valleys of California, the Yuma Valley of Arizona, Florida, Mexico, and, of course, the Matanuska Valley of Alaska. Plant scientists from California and Arizona were questioned about the types and/or varieties of vegetables shipped to Alaska from these areas. In addition, Anchorage retailers and wholesalers provided information about the types and varieties of salad vegetables handled by their firms.

Price and quantity data relating to salad vegetables were obtained from major wholesale-produce firms in Anchorage. These wholesalers supply a major part of the salad vegetable market of the Kenai Peninsula, the commissary at one of the military bases in the area, and a significant portion of the Anchorage civilian market.[1] Data were also collected from two major fresh vegetable retailers in the area who are supplied

1. Personal interview with Mr. John Falcone, Alaska Wholesale, Inc., Anchorage.

TABLE 1. SALAD VEGETABLE TYPES AND VARIETIES.

Head Lettuce	Leaf Lettuce	Tomatoes	Radishes	Cucumbers	Green Onions
Calmar	Romaine	Early Pak 7	Cherry Belle	Saticoy	White Sweet Spanish
Iceberg	Red leaf*	Floradel	Scarlet Globe	Triumph	Beltsville Green-Bunching
Climax	Bib*	Tropic	Diakon	Long Green Marketeer	
Vanguard		Walter			
Great Lakes 659		Ace			
Mesa 659		Cherry Tomatoes*			
Golden State D					
Empire					

* Varietal names not provided

Source: Dr. W. Sims, University of California, Dr. A. E. Thompson, University of Arizona, and various Anchorage vegetable wholesalers and retailers.

by wholesalers located in the lower 48 states. In addition, military bases in the area furnished data relating to the procurement of salad vegetables.[2] All data collected were for 1972.

Results and Discussion

Table 1 lists the principal types and varieties of salad vegetables delivered to Alaska. Plant scientists and wholesalers interviewed cautioned that types rather than specific varieties should receive greatest consideration in selecting plants to be produced and sold locally. This is because vegetables are normally marketed by type such as "red leaf lettuce" and because varieties tend to lose their identities in the marketplace after the vegetables are shipped from their place of origin.[3]

Although price and quantity data were for 1972, prices to wholesalers and sales of these vegetables apparently were generally at about the same level in 1973.[4] Thus, the 1972 data should approximate the dimensions of the current market. Table 2 shows the average monthly prices paid by wholesalers for the different vegetables.[5] Since only one year's data were available, no attempt was made to isolate seasonal patterns of price movement. As expected, however, the data show significant shifts in the prices of some vegetables during certain times of the year.

Tables 3 and 4 show, respectively, the quantities and values of salad vegetables entering the Anchorage area and Kenai Peninsula markets in 1972. These data include purchases by military installations for troop issue and for commissaries. Again, no attempt was made to measure seasonal patterns. Table 3 indicates, however, some decline in quantities of selected vegetables during August and the early part of September when local gardens were in production. The major forces causing seasonal movements in the quantities in Table 3, however, might be factors affecting supply rather than demand for these vegetables. Availability of this produce probably is a strong determinant of the quantity which reaches the Alaska market.

The information in Tables 3 and 4 indicates that head lettuce and tomatoes are the two most important salad vegetables in the market and head lettuce dominates the lettuce market. In terms of quantity and value, head lettuce accounts for about 95 percent of the lettuce in the market.

The total market (quantity-wise) that local growers would actually face could be somewhat smaller than that suggest-

Table 2. Prices of Salad Vegetables Paid by Wholesalers, 1972. (Price Per Pound)

Month	Head Lettuce	Leaf Lettuce[a]	Tomatoes	Radishes	Cucumbers	Green Onions
January	$.16	$.20	$.47	$.21	$.21	$.28
February	.15	.24	.44	.24	.29	.30
March	.17	.23	.41	.24	.28	.30
April	.17	.24	.34	.24	.21	.30
May	.22	.23	.35	.25	.21	.31
June	.23	.25	.35	.24	.19	.30
July	.18	.21	.47	.22	.14	.27
August	.16	.20	.42	.23	.11	.28
September	.16	.20	.32	.23	.10	.28
October	.13	.21	.32	.25	.11	.28
November	.14	.22	.36	.25	.12	.28
December	.16	.24	.42	.23	.14	.28
Weighted Average	.17	.22	.39	.24	.16	.29

a The price of leaf lettuce presented here is a weighted average of the prices paid for Romaine, red leaf, and bib lettuce.

2. Mr. Lloyd Lindsay of Alaska Fish and Farm, Anchorage, indicated in a personal interview that by collecting data from the military bases, the Anchorage produce wholesalers, and the two large produce retailers, approximately 90 percent of the salad vegetable market in the area would be accounted for.
3. This view was expressed by Dr. William Sims, Extension Vegetable Specialist, University of California, Davis and by Dr. A. E. Thompson, Head, Department of Horticulture and Landscape Architecture, College of Agriculture, University of Arizona, Tucson.
4. Interview with John Falcone.
5. Included in the determination of these prices are figures given by the Anchorage produce retailers who are supplied by produce wholesale firms located in the lower 48 states. The military installations did not provide information on prices. All price figures obtained were FOB Anchorage.

Table 3. Quantities of Salad Vegetables by Weight: Pounds per Week.

Month	Head Lettuce	Leaf Lettuce[a]	Tomatoes	Radishes	Cucumbers	Green Onions
January	102,866	3,575	40,536	3,967	10,000	5,692
February	123,863	3,054	43,859	4,365	8,713	6,245
March	98,693	3,720	43,800	4,180	7,284	5,780
April	122,902	5,207	58,740	4,802	9,477	6,347
May	87,842	5,227	68,682	5,535	12,761	6,746
June	101,847	5,351	58,433	6,668	13,058	7,144
July	85,265	3,956	57,041	6,752	15,830	7,739
August	90,736	3,282	43,359	6,377	15,557	6,946
September	72,408	3,265	46,442	6,248	15,000	7,172
October	87,474	2,882	49,482	4,434	13,784	5,689
November	83,009	3,349	43,679	4,456	12,965	5,653
December	89,243	3,003	44,568	4,325	10,966	5,843
Weighted Average	95,298	3,825	49,919	5,179	12,138	6,416
Annual Total	4,955,490	198,892	2,595,800	269,303	631,200	333,654

a This column includes Romaine, Red leaf, and bib lettuce.

Table 4. Wholesale Value of Sales of Salad Vegetables : Average Weekly Data, 1972.

Month	Head Lettuce	Leaf Lettuce[a]	Tomatoes	Radishes	Cucumbers	Green Onions
January	$ 16,527	$ 697	$ 18,849	$ 825	$ 2,060	$ 1,588
February	18,882	724	19,210	1,061	2,535	1,898
March	17,107	844	18,046	1,003	2,069	1,734
April	21,030	1,255	19,854	1,172	2,000	1,929
May	19,032	1,223	23,833	1,356	2,731	2,340
June	23,877	1,327	20,218	1,614	2,494	2,165
July	15,594	839	26,980	1,479	2,248	2,120
August	14,115	640	18,297	1,448	1,665	1,966
September	11,215	656	15,047	1,418	1,470	2,030
October	11,274	602	15,933	1,117	1,544	1,593
November	11,953	700	15,724	1,110	1,556	1,577
December	14,378	712	18,719	1,008	1,557	1,630
Weighted Average	16,223	852	19,238	1,218	1,991	1,830
Annual Total	$843,576	$44,280	$1,000,356	$63,333	$103,522	$97,779

a See Table 3.

ed by the data in Tables 3 and 4; this is because loss due to waste and shrinkage would likely be less with locally grown produce. Anchorage wholesalers indicated that these waste and shrinkage factors vary with the kind of vegetables, season, weather, and area grown.[6]

Further refinement of the data (not shown) indicated that the percentage distribution of the total market among three components (greater Anchorage civilian, military bases, and Kenai Peninsula) varied somewhat for the different vegetables. Generally, however, the Kenai Peninsula accounted for 5 percent of the market, military installations, 15 percent and the Anchorage civilian population 80 percent of the salad vegetables entering the market. This breakdown may be of particular interest to the Wildwood operation and other greenhouse producers as they seek to supply larger segments of the local market with salad vegetables.

The results of this initial market survey will provide scientists with information regarding which vegetable types to consider or to emphasize in the study. It should be recognized, however, that recommendations for commercial production cannot be made on the basis of results reported here. Rather, these recommendations must await the outcome of the research at Wildwood. □

6. Interviews with John Falcone and Mr. Jerald Mount, Pacific Fruit and Produce Co., Anchorage.

Sweet Holygrass, A Potentially Valuable Ally

L.J. KLEBESADEL
Research Agronomist

Grasses represent a large family of plants worldwide and they are used in many ways. According to Agnes Chase, one of the world's foremost authorities on grasses:

> *"Of all plants, the grasses are the most important to man. All our breadstuffs – corn, wheat, oats, rye, barley – and rice and sugarcane, are grasses. Bamboos are grasses, and so are the Kentucky bluegrass and creeping bent of our lawns, the timothy and redtop of our meadows."*

One of Alaska's native grasses is known by many common names and has been put to uncommon uses: Sweet holygrass, vanilla grass, sweetgrass, Seneca grass, foin d'odeur – all are common names for the same species *(Hierochloe odorata)*. Its scientific name was taken from the Greek *hieros* = sacred, and *chloe* = grass.

In olden times, this sweet-scented grass was "strewn before churchdoors on saints' days in the north of Europe." Halfway around the world, Indians in North America have used the long leaves to weave fragrant baskets.

Holygrass has an extensive natural range, being common above 40° north latitude in Asia, Europe, and North America. In Alaska, this species is common over most of the southern part of the state, becoming more rare to the northward. However, it has been found as far north as 70° near the arctic coastline. Two other species of holygrass are known in Alaska; these are alpine holygrass *(H. alpina)*, and arctic holygrass *(H. pauciflora.)*

Sweet holygrass is one of the multitude of native Alaskan species that has been collected in the wild and grown in research nurseries at the Institute of Agricultural Sciences in the Matanuska Valley. Over a decade of such plant exploration and evaluation was made possible in Alaska by grant funds supplied by The Rockefeller Foundation. Sweet holygrass was identified early as a grass which spreads by underground stems (rhizomes) with amazing rapidity. No central tuft or clump developed as is common in most other grasses.

No wealth of foliage is produced and so this grass offers little in the way of forage production. Moreover, it does not develop sufficiently dense growth to be valued as a turf.

There is, however, a third major avenue for utilization of grasses in Alaska – soil stabilization. Rapidly increasing construction activities often leave

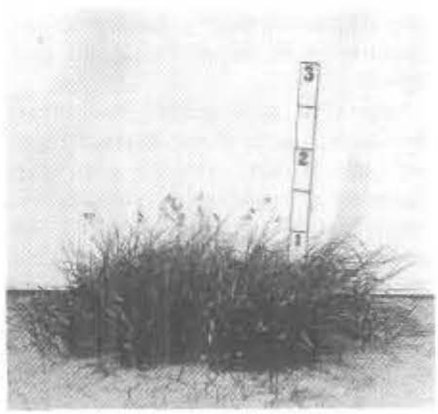


Figure 1. Two photos of the same single plant of sweet holygrass transplanted as a 1-inch plug from Northway, Alaska in June 1968. At the time of the upper photo, approximately one year later (1 July 1969), the plant had spread to cover about 10 square feet. When the lower photo was taken the following year (1 September 1970), the plant had spread to bind the soil in an area covering more than 50 square feet. Numbers on the stake indicate height in feet. Note the scarcity of seed heads.

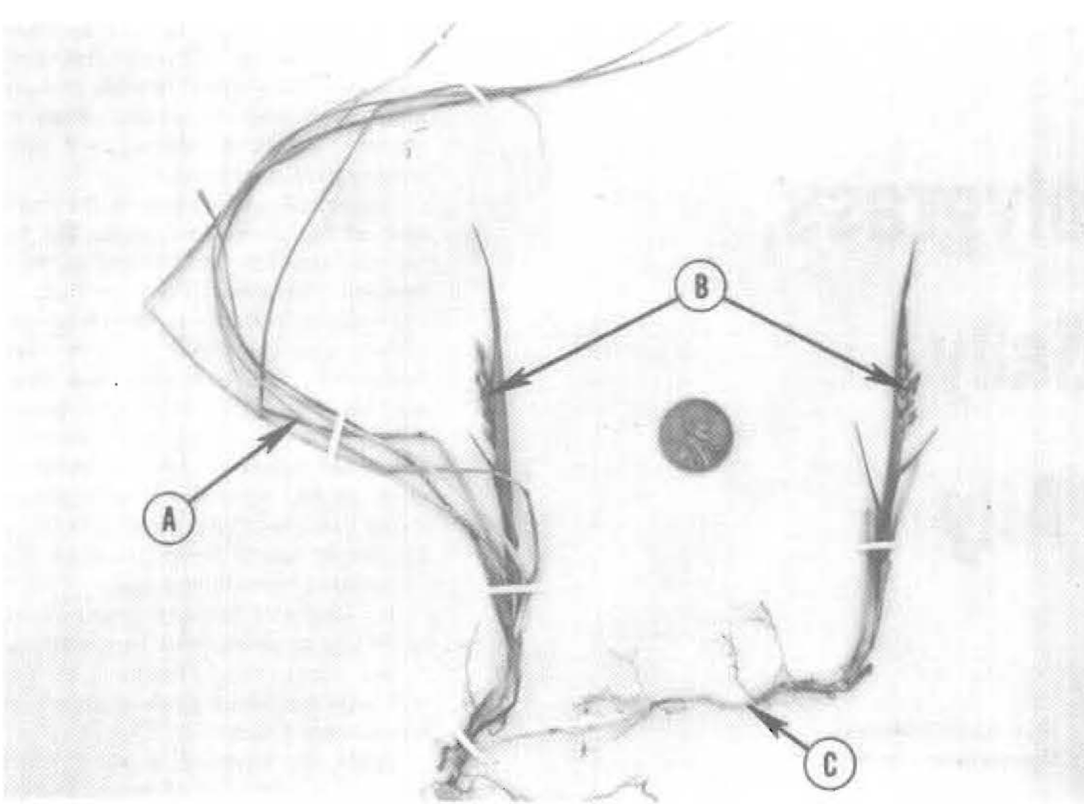


Figure 2. Portion of sweet holygrass plant photographed 13 May. A=old growth from previous year. B=panicles (seed heads) emerging coincident with early growth of leaves; C=rhizome (underground stem.)

exposed soil materials that require revegetation to prevent wind and/or water erosion as well as for esthetic considerations. Sweet holygrass possesses the valuable inherent ability to spread rapidly, providing aerial cover for the soil and binding the soil through underground development. A square foot of underground rhizome and root growth was dug from the plant in Figure 1. When washed free of soil, it was found that the tight mat of rhizomes and roots was so extremely dense that light could scarcely pass through it.

Another plus for this grass, when used for soil stabilization, is the limited height of top growth; it therefore would require minimum maintenance. Taller-growing grasses usually require mowing to maintain them in good appearance.

The most common method for artificially propagating grasses is through seed production and subsequent planting. Sweet holygrass is poorly suited for this role, however, as it is a poor seed producer. In general, it produces relatively few seed heads (Fig. 1), and those contain few seeds.

If holygrass is to be utilized for soil stabilization, a satisfactory means must be available for propagating it. The most obvious would appear to be vegetative sprigging. This means is commonly used in some southern states to propagate bermudagrass.

As currently used elsewhere, this technique involves harvest of living rhizomes or stolons (above-ground creeping stems), cutting these into short segments, and replanting those propagules.

Vegetative propagation has certain advantages, as well as disadvantages, over use of seed. On the plus side, vegetative propagation circumvents the hazard of seed shattering. Grasses differ greatly in their susceptibility to this loss, but windy conditions near the time of seed maturity can drastically reduce the harvested seed yield of certain grasses, as dislodged ripe or nearly ripe seed falls to the ground. Another advantage of vegetative propagation is the longer season for harvest. Seed must be harvested on a very timely basis near maturity; vegetative propagules may be dug over a longer portion of the growing season. Still another advantage of vegetative propagation is the greater ease of establishment. Grass sprigs produce more vigorous new growth than seeds, and may be disked deeper into the soil than seed, insuring better moisture conditions for early growth.

Vegetative propagation also has some disadvantages. It involves handling a much bulkier product that is more susceptible than seed to damage from harmful drying during handling. Vegetative sprigs cannot be stored for long periods, as seed can. Transporting vegetative propagules to remote areas, and planting in rocky terrain would be more difficult than with seed. Moreover, specialized equipment, not commonly in use, is required for vegetative propagation.

Phenologically, sweet holygrass is among the earliest of Alaskan grasses. Seed heads appear early in May, almost as soon as the grass begins spring growth (Fig. 2). Anthesis (pollen dispersal) occurs near May 20, and seed is ripe in late July to early August. Seed heads that will emerge the following growing season are formed in autumn and remain tiny and hidden during winter in the new growing shoots, which elongate the following spring. Formation of seed heads before winter's arrival permits earlier emergence of seed heads the following spring and better utilization of the relatively short growing season of high latitudes. This is a characteristic of this species and most other high latitude grasses, a behavior pattern virtually unknown in temperate latitudes where the minute beginnings of grass seed heads usually do not appear at the growing points until after winter has passed.

Sweet holygrass is one of many native Alaskan grasses that are being evaluated for various uses in ongoing programs to find solutions to problems requiring plant resources. Further trials will disclose whether the obvious, inherent values of sweet holygrass for soil stabilization can be utilized effectively. If not, well . . . we can always weave baskets with it, or scatter some in front of our church doors. □

Alfalfa Pellets Increase Dry Matter And Protein Of Oat-Pea Silage

A. L. BRUNDAGE
Professor of Animal Science

Frozen silage has always been a hard problem when feeding the dairy herd at the Institute's Matanuska Farm during the winter. Sub-freezing temperatures combined with limited sunshine cause the silage to freeze, both inward from the walls of our tower silos, as well as at the exposed upper surfaces. The higher the moisture content of the silage, the more difficult it is to remove frozen material from the silo, either by hand or by mechanical unloaders. It helps to wilt fresh herbage to 60 per cent moisture or less prior to ensiling. Moisture levels often are in excess of 70 per cent in the standing crop, however, and cool, damp weather during harvest makes further drying difficult.

If moisture content cannot be reduced sufficiently by wilting, silage dry matter can be increased by adding dry material at the time of ensiling. Alaskan dairy farmers often import some of the roughage requirements of their herds. Imported roughages high in nutritive value relative to unit weight and volume, such as alfalfa pellets, can be used to increase both silage dry matter and protein content.

An experiment was initiated at the Matanuska Farm in 1972 to study the use of alfalfa pellets in oat-pea silage. Twenty metric tons of oat-pea herbage were ensiled in one silo at 71.6 per cent moisture, for comparison with 24 metric tons of similar herbage mixed with 5.3 metric tons of alfalfa pellets at 9.3 per cent moisture and placed in a second silo. The moisture content of the oat-pea-alfalfa mixture was estimated at 60.0 per cent.

The silos were opened on 10 January 1973, and the silages fed to six lactating dairy cows during the ensuing 3½ months in a switchback feeding trial (1). Three feeding periods of thirty-five days each were used, with the initial five days during each period reserved for animal adjustment to the rations. All animals were weighed on three consecutive days at the start and completion of a period. Milk production was recorded twice daily and sampled each week for milk fat determination.

The two experimental silages were the only roughages fed. They were weighed and fed individually to each animal twice daily. Maximum intake was assured by adjusting allowances to provide a small residual each day. This was weighed and discarded each afternoon, providing a continuous record of silage intake during the course of the study.

Table 1. Formulation of concentrate used.

Ingredient	Kilograms
Barley	1000
Oats	500
Alfalfa meal	200
Molasses	100
Soybean oil meal	100
Meat & bonemeal	100
Salt	20
Trace minerals	4
Vitamin A (True, dry)	5000 I.U./kg mixed feed
Vitamin D_2 (dry)	8800 I.U./kg mixed feed

Formulation of the concentrate portion of the rations fed is shown in Table 1. The quantity of concentrate fed was adjusted weekly according to Morrison's recommendations for cows on the usual allowance of good roughage (3). Grain feeding was based on the theoretical lactation curve computed for each cow prior to the start of the experiment, to prevent ration effects during one period from influencing feeding levels during subsequent period(s) (2).

The silages and concentrate were sampled weekly. A portion of each sample was used to determine moisture content and silage acidity (pH). The concentrate samples were composited into one sample for chemical analysis; the silage samples were analyzed individually to provide an indication of the variability of each silage as it was fed from the silo. Analyses included nitro-

Table 2. Chemical Composition of Feeds Used.

Feed	pH	H_2O	Crude protein	Cell wall constituents	Acid detergent fiber	Lignin
		Per cent				
As put into the silo:						
Oat-pea herbage		71.6	9.2	53.4	35.4	6.0
Alfalfa pellets		9.3	17.9	50.6	38.6	7.6
Oat-pea-alfalfa pellets		60.0	12.8	52.2	36.7	6.5
As fed:						
Oat-pea silage	4.2	71.2**	8.5**	53.5	36.7	7.1
Oat-pea-alfalfa pellet silage	4.8	60.2**	13.1**	54.8	38.9	8.0
Concentrate		11.6	14.7	23.2	11.0	3.3

**Differences are significant at the 1% level of probability.

Table 3. Feed Intake and Animal Production

Ration	Feed intake/day: Concentrates as fed	Concentrates dry matter	Silages as fed**	Silages dry matter*	Animal production/day: 4% milk	Liveweight**	Liveweight change
	Kilograms						
Oat-pea silage	4.0	3.5	40.9	10.2	13.5	582	+0.1
Oat-pea-alfalfa pellet silage	4.1	3.6	27.6	12.7	13.9	567	+0.3

*Differences are significant at the 5% level of probability.
**Differences are significant at the 1% level of probability.

Table 4. Nutrient Requirement and Intake

Ration	Digestible energy	Protein: Total	Protein: Digestible
	Megacalories	Grams	
Oat-pea silage:			
Requirement	38.1	1772	1026
Intake	38.1	1382	845
Oat-pea-alfalfa pellet silage:			
Requirement	38.3	1790	1041
Intake	44.9	2193	1255

gen for crude protein, cell wall constituents, acid detergent fiber, and lignin, in addition to pH and moisture.

The chemical composition of the feeds used are shown in Table 2. The oat-pea herbage and oat-pea-alfalfa mixture were very similar in structural components such as cell walls, acid detergent fiber, and lignin at the time of ensiling. The addition of alfalfa pellets increased the protein content from 9.2 per cent for oats-peas to 12.8 per cent for oats-peas-alfalfa.

Similar relationships were observed when the silages were fed, suggesting that most of the nutrients ensiled were recovered from the silos. Analytical values of the individual silage samples were more varied for the oats-peas-alfalfa than for the oats-peas. This is attributed to poor mixing of the oats-peas with the alfalfa pellets which were added to the fresh herbage at the silo filler. Differences in density of the pellets and fresh herbage resulted in separation of these two components in the air stream as they were blown into the silo.

Feed intake and animal production data are listed in Table 3. The cows ate significantly more of the higher moisture oat-pea silage than the oat-pea-alfalfa silage. However, they consumed more of the latter on a dry-matter basis. Daily milk production and liveweight gains were slightly higher for the cows consuming oat-pea-alfalfa silage. Neither ration appeared to adversely affect the percentage of milk fat in the milk.

Digestible energy and protein requirements of the cows receiving the two rations were estimated from the National Academy of Sciences Nutrient Requirements of Dairy Cattle (4), and are shown in Table 4. Estimated intake is also shown in this table and was calculated by assuming that digestible energy was 2.6 and 3.3 megacalories per kilogram of dry matter and that protein digestibility was 50 and 80 per cent for both silages and the concentrate respectively. Intake of digestible energy was adequate on both rations, but intake of total and digestible protein was below requirements on the oat-pea silage.

Results from this limited experiment support the feasibility of increasing the dry matter of oat-pea silage by the addition of alfalfa pellets at the time of ensiling. Although both silages did freeze, oat-pea-alfalfa silage, with lower moisture content, was more easily removed from the silo. The protein content of the ensiled material was increased by the addition of alfalfa pellets. This additional protein was recovered in the silage and helped meet the protein requirements of dairy cows supplemented with blended concentrate containing 15 per cent protein. □

REFERENCES

1. Brandt, A. E. 1938. Tests of significance in reversal or switchback trials. Iowa Agr. Expt. Sta. Research Bull. 234.
2. Lucas, H. L. 1960. Critical features of good dairy feeding experiments. J. Dairy Sci. 43:193.
3. Morrison, F.B. 1948. Feeds and feeding. 21st ed. The Morrison Publ. Co., Ithaca, New York.
4. National Academy of Sciences. 1971. Nutrient requirements of dairy cattle. 4th ed., Washington, D. C.

Prospecting for Green Gold

JAY D. McKENDRICK
Assistant Professor, Agronomy

FIGURE 1. A view of some bluejoint ranges along the Talkeetna Mountain slopes north of Palmer in the Matanuska Valley.

Alaska's natural resources have contributed significantly and will apparently continue to supply much to the wealth and material needs of the United States. This is obvious from Alaska's historical and potential production of minerals, coal, natural gas and petroleum.

Not all Alaskan prospectors have sought non-renewable resources, however. The "gold rush" of the 1800's in other western states attracted not only miners, but also agrarian pioneers who developed an industry that eventually surpassed the mining interests in economic importance. Modern counterparts of those pioneers recognize food production potentials in Alaska which might be likened to "green gold."

Turning Grass Into Steak

Successfully turning Alaska's "green gold" into steaks and hamburgers will likely cost more, and require more planning and management than went into developing the open ranges of the Great Plains. Even though some of the native grasslands in Alaska annually produce 1 to 2 tons of forage per acre (dry-matter basis), most of those grasslands are summer ranges only, and livestock need year-round feeding supplies. Thus, for each acre of rangeland used for domestic livestock grazing, several acres of cropland must also be available for spring and fall pasture and for winter feed supplies.

In southcentral Alaska, most natural grasslands endowed with stands of bluejoint *(Calamagrostis canadensis)* remain unharvested each year because native herbivorous animals are adapted to feeding on other plant species, range beyond the geographical limits of the bluejoint stands, or are too few to significantly harvest the forage. It is noteworthy to consider the ecological implications of grasslands existing naturally which apparently receive so little impact from grazing herbivores; the lack of grazing pressure on bluejoint stands has not encouraged natural selection for ecotypes tolerant to animal grazing. Previous work (1, 4) and observations by Alaskan ranchers verify that bluejoint stands have low tolerances to grazing pressures.

Research Priorities

What range-research priorities should be set to assist persons who either are developing or contemplate developing livestock operations in Alaska? Since 1946, several experts, including O.S. Aamodt, D.A. Savage, Charles D. Story, C. Wayne Cook, and Howard B. Passey, have been called upon to advise on that question.

Aamodt and Savage were members of a task force which investigated agricultural problems in Alaska in 1946. Their recommendations were directed toward developing winter feed supplies (1). C. Wayne Cook, a renowned range expert at Colorado State University, indicated that in order to develop plans for using the ranges of Alaska, those ranges must first be mapped and inventoried (2). Howard Passey of the Soil Conservation Service, independently echoed that statement. More recently a noted plant ecologist wrote concerning the use of native vegetation: "Wherever a sizeable area of natural vegetation is to be managed intensively, maps of that area are necessary. Only by means of a map can one readily comprehend what ***kinds*** of landscape units are present, and how ***much*** of each there is, and their ***pattern of distribution***, all of which are essential for planning and management," (3).

Range management is a form of applied plant ecology wherein animal grazing is variously manipulated in order to obtain maximum livestock production while maintaining the vigor of the basic resource – the range forage plants. Range managers must therefore be familiar with a wide range of academic disciplines in order to most effectively understand the range ecosystem. Likewise their informational needs from research programs range widely from the general scope of the range inventory to the specific growth requirements of key range plants.

Initiating range research programs for Alaska should include a balancing of general and specific scale projects to best serve the range livestock industry. Two research projects, one general in scope and one specific, are suggested as having high priorities among those needed.

Vegetation Maps Have Priority

Vegetation maps have priority for portraying information usable for either locating range sites or developing range-management plans. Thus, a first priority for domestic livestock range-research should be to map the vegetation resources, beginning in the areas surrounding existing croplands -- the essential bases for range livestock operations (Fig. 1). Alaskan ranges need to be mapped at the 1:63,360 (1 inch = 1 mile) scale in order to determine their distribution patterns with respect to land ownerships (i.e., state, federal, etc.). Once the extent and locations of the ranges are known, investors can plan range operations, determine accessibility and assess marketing problems, estimate the acres of winter feed and pasture needed, and use these in calculating the economic feasibility of such operations.

The second major objective should be to study how best to manage the key range grasses, (e.g., bluejoint, fescue, hairgrass, bluegrass) for sustained yields. We already know that bluejoint grows so rapidly during the brief Alaskan summer that patchy grazing patterns develop unless heavily grazed early in the season. Standing dead material and litter accumulations further accentuate this problem. Furthermore, heavy grazing seriously weakens the grass stand.

In most native grasslands, fire is a natural factor which eliminates not only the accumulation of dead materials, but also controls the encroachment of woody plants. What effects do fire and/or other litter-removing and other management treatments have on bluejoint stands? Research should provide needed answers.

To manage and use any plant, whether a grass or vegetable crop, we must also know the plants' growth requirements. Acquiring such knowledge involves autecology and plant physiology studies. For example, during the growing season, bluejoint not only produces herbage above-ground; it also produces buds, and stores carbohydrates below-ground. Removing herbage when it is crucially needed by the plant for production of photosynthate (used for bud development [Fig. 2] and carbohydrate reserves) could seriously reduce forage yields during subsequent growing seasons.

The mineral nutrition of Alaskan range grasses must also be considered. The soils of Alaska are inherently infertile by most agricultural standards even though such soils may support lush stands of native grasses. How can the native grasses grow so well under such conditions? There are a few possible explanations, but little supporting evidence currently available. One speculation is that these grasses have relatively low mineral nutrient requirements. Evidence favoring that theory is the very low content of calcium and phosphorus reported for bluejoint (1). Another possibility is that minerals are recycled within the plant, that is, much of the mobile nutrients used in producing growth one year is stored in rhizome and bud tissues and reused during the following growing season. The rapid decline in nitrogen content of bluejoint as the shoots mature indicates the likelihood of such a process. Regardless of which factor or combination of factors is responsible, the impact of removing large amounts of forage from the ecosystem by either grazing or mowing would significantly imbalance the natural nutrient cycle.

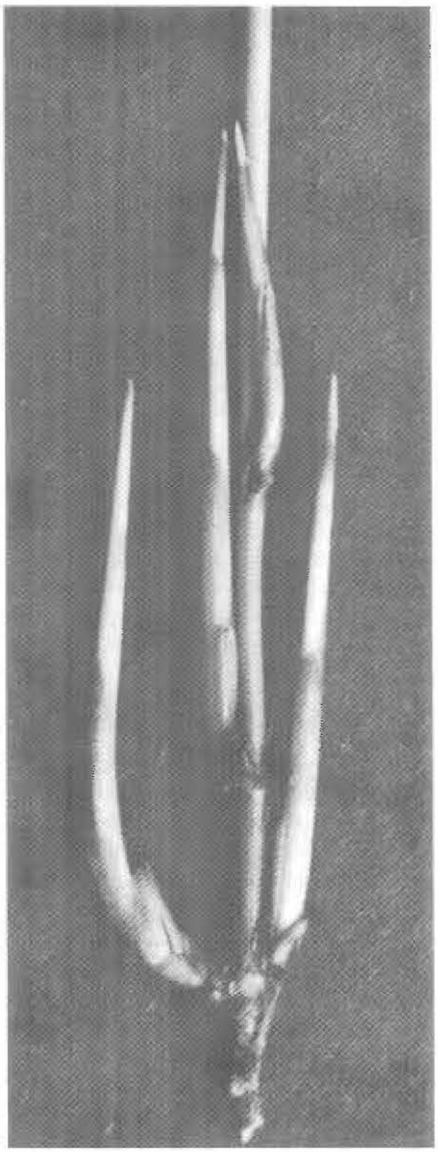


FIGURE 2. Close-up of bluejoint's basal buds which develop during August, over-winter as seen here and then grow into aerial shoots the following summer.

Project Plans

A detailed study of the carbohydrate and mineral cycling of bluejoint is currently underway at Palmer. Forage and rhizome samples were collected each week for over a year. Those tissue samples are being analyzed in the laboratory. Findings in this study should indicate when during the growing season the plant is most vulnerable to mowing and grazing pressures and when to harvest for maximum amounts of high-quality hay. We should also have some clue as to quantities of soil nutrients needed and recycled each year by this plant.

Summary

By properly applying remote sensing from satellites we will be able to produce range inventory maps for areas surrounding and including prime agricultural sites in Alaska. This is a most important objective because these maps will provide not only an estimate of the range resources but also where the best ranges are located with respect to specific township and sections. Proper utilization of that range resource will then be based on management that is found to be compatible with the needs of the range grasses. Thus, in searching for and utilizing Alaska's "green gold," as with the searches for "yellow" and "black" gold, the efforts begin with a map. □

REFERENCES

1. Aamodt, O.S. and D.A. Savage. 1949. Report on exploratory investigations of agricultural problems of Alaska. Ch. 3. Cereal, forage and range problems and possibilities in Alaska. U.S.D.A. Misc. Publ. No. 700. P. 87-124.
2. Cook, C. Wayne. 1971. Views in evaluating Alaskan efforts in range livestock production for the future. Agroborealis. 3(1):20.
3. Daubenmire, R. 1973. A comparison of approaches to the mapping of forest land for intensive management. The Forest Chronicle. 49:87.
4. Mitchell, Wm. W. 1969. Sub-alpine rangeland requires careful management. Agroborealis. 1(1):4.

Phosphorus Fixation Problems In Some Alaskan Soils

GEORGE A. MITCHELL
Laboratory Technician

Farmers, extension workers and agricultural researchers familiar with Alaskan soils are aware of the importance of phosphate fertilizer in obtaining increased crop yields. This importance is matched by its complexity in the soil system. Phosphorus (P) in soil is held, for the most part, in insoluble chemical compounds which render it unavailable to the plant. The portion that is available or potentially available is present in a variety of forms and availability is dependent to some degree on soil acidity or alkalinity (pH), texture, and organic matter content of the soil. The pH controls primarily the inorganic forms, with iron and aluminum phosphates predominating in acid soils and calcium phosphate in soils at higher pH values. Phosphorus sorption[1] and fixation by soils is highly influenced by texture (particle size) and organic matter content, particularly in acid soils.

Despite the large number of studies involving phosphate fixation problems, the exact mechanisms that determine the availability of phosphorus to the plant are not fully understood. It can be said, however, that a given soil's capacity to fix phosphorus will strongly influence the availability of applied fertilizer P to the plant. This fixation problem was emphasized in soil analysis data obtained from a recent fertilizer study conducted on the lower Kenai Peninsula near Homer.

Fertilization Study

The plots in question were established on a stand of native Alaskan bluejoint grass *(Calamagrostis canadensis)* in 1970 by Dr. William Mitchell and fertilized annually with various rates of N, P, and K (0, 50, 100, and 160 lb P per acre). Available soil P was estimated by extracting the samples with Bray P-1 extracting solution (0.03 N NH_4F in 0.025 N HC1) and determining the P concentration by the molybdate blue method of Bray and Kurtz (1). Phosphorus levels obtained in these plots ranged from 7 to 158 lb P per acre but demonstrated little correlation with P fertilizer applications or bluejoint yields.

Extracting Solutions Tested

It was at first thought that the apparently erratic soil test results possibly were due to poor extraction of available P by the Bray P-1 solution. Other extracting solutions were tested using two soils, one testing high in P and another testing low. Each soil was extracted with Bray P-1, Bray P-2 (0.03 N NH_4F in 0.1 N HC1), Morgan's solutions (10% sodium acetate in 3% acetic acid at pH 4.8), Olsen's solution (0.5 N $NaHCO_3$) and distilled water. The results indicated that the problem was not in the extracting solution since all solutions tested gave results consistent with the Bray P-1 values.

Soils Tested

It was then conjectured that the difficulty might be associated with the phosphate fixation capacities of the soils involved. To test this, four soils were selected for fixation studies, three from the bluejoint plots and one from within a thicket of alder *(Alnus crispa)*. All four soils are classified as Kachemak silt loams.

A one-gram sample of each soil was weighed into each of four flasks and to the flasks was added in solution the equivalent of 0, 250, 500 and 1000 lb of P per acre. The flasks were shaken for 5 minutes, and filtered. The difference in concentration of P in the original solutions and in the filtrate is equal to the amount sorbed by the soil. The soils were allowed to dry overnight and then extracted with Bray P-1 solution. The amount remaining in the soil after extraction is taken as the approximate P fixation by the soil

Figure 1 shows the sorption and fixation patterns of soils from the bluejoint plots at different applied P levels. The top curve for each soil represents P sorption, the lower curve represents the amount of P fixed and the portions with hatching and cross-hatching is Bray-extractable P. Soil 3 demonstrated a very high sorption and fixation capacity. For instance, when P was applied at 500 lb per acre, 425 lb per acre was sorbed and of this about 350 lb per acre was fixed. Soil 2 behaved much the same as soil 3 at lower rates of applied P, but at higher rates demonstrated less fixation and appeared to be approaching a maximum near 400 lb per acre of fixed P. Soil 1 showed considerably less sorption capacity than the other two, reaching a maximum at about 260 lb per acre sorbed P, and demonstrated practically no fixation. The negative sorption values simply indicate the soluble and extractable P present in the soil before additional P was applied.

The sorption pattern for soil 4 (Figure 2) which was taken from an alder thicket was very similar to that of soil 1 in that it demonstrated low sorption and no fixation.

Two Different Soils

From this fixation data and the soil properties summarized in Table 1, it

1. The term 'sorption' refers to phosphorus taken up and held by adsorption, absorption or both.

TABLE 1. SOIL CHEMICAL AND PHYSICAL PROPERTIES

Soil No.	pH[a]	Apparent[b] density gm/cc	Organic matter[c] content %	Available[d] P lb/A
1. (Bluejoint)	4.0	0.52	44.5	158
2. (Bluejoint)	4.7	0.67	22.2	18
3. (Bluejoint)	5.2	0.68	19.1	18
4. (Alder)	4.0	0.30	52.3	36

a 1:1 soil to water ratio.
b Average of 10 determinations on air-dried soil.
c By combustion at 550°C for four hours.
d Bray P-1 extractable.

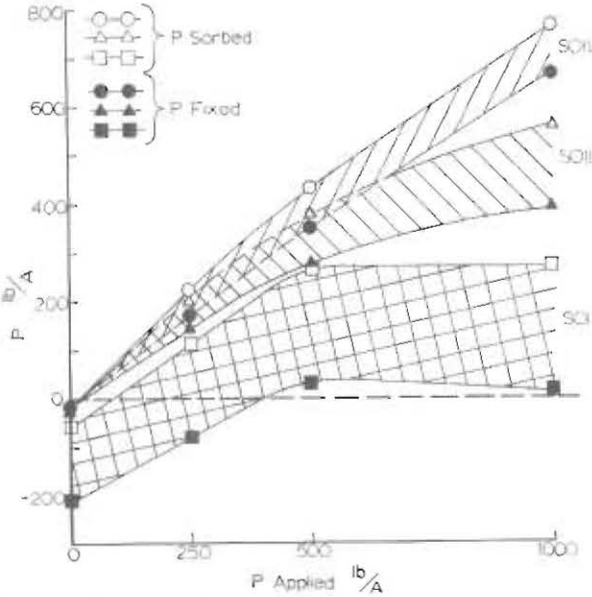


FIGURE 1.

Phosphorus sorption and fixation patterns for soils sampled from bluejoint plots.

becomes increasingly obvious that essentially two different soils are involved. One soil (2 and 3) has a pH near 5, a high apparent density, a comparatively low organic matter content, and a high sorption and fixation capacity. The second soil (1 and 4) has a pH value one unit lower, a lower density, a very high organic matter content, and a low sorption and fixation capacity for phosphorus. The similarities between soils 1 and 4 offer strong evidence that soil 1 was probably formed under alder. Considering the magnitude of differences in P fixation capacity found in these soils, together with the very significant acreage of soils on which alder has grown in this region; the result is possibly a P fertility problem. Problems associated with establishing crops in the highly organic and acidic soils formed under alder have been reported previously (3).

The exact nature of these difficulties has not been fully determined, but phosphate fixation or lack of fixation could be a contributing factor. In the case of the alder soil studied here, the phosphorus that was sorbed was held very weakly as evidenced by the low fixation. This could result in an initially high availability of P for plant uptake but a low capacity for replenishing the soil solution.

In a study of acid soils in North Carolina containing both low and high organic matter, Daughtrey et al. (2) found great variations in the amount and rate of release of fixed phosphate. Soils that demonstrated a pattern of increasing P release with successive leaching were more highly fertile with respect to P than were soils that released a large amount initially and decreasing amounts with successive leaching.

In soils 2 and 3, the high fixation of P was most likely the result of the formation of sparingly soluble compounds with iron, aluminum and manganese. This fixed P, however, is not completely lost to the plant. As plant roots remove P from the soil solution, the resultant change in equilibrium allows some portion of the fixed P to enter solution. Whether the amount and rate of this dissolution is sufficient to provide adequate P nutrition for a given plant species is largely dependent on soil properties and the form in which the P was originally fixed. Since plants require a relatively low concentration of P in solution at any one time, high-fixation soils may actually be higher in P fertility than low fixation soils, even though a routine soil test may indicate otherwise.

In the bluejoint plots, 10 out of 24 fertilized plots tested as low or lower in available P as the unfertilized plots. In contrast, the plant tissue from the fertilized plots was found to have P concentrations from 2 to 3 times higher than in the unfertilized plots. These observations suggest: (a) the bluejoint plants absorbed much of their needed phosphorus supply earlier in the growing season when soil P levels were higher than reflected by the soil tests or (b) the plants have the capacity to absorb some portion of the supposedly fixed P.

Additional Studies Needed

Results of this study do not provide any firm answers on how to properly manage the phosphate fertility of these soils, but they do indicate where additional studies are needed. Perhaps the most important question to be answered is to what extent fixed P is available for plant use. For instance, what level of P application is needed to satisfy the fixation capacity and also provide the plant with adequate nutrition? Routine soil tests currently being used for phosphorus are important for monitoring available P levels in soil, but do not answer some of the basic questions regarding its chemical nature in the soil system. □

REFERENCES

1. Bray, R. H. and L. T. Kurtz. 1945. Determination of total, organic, and available forms of phosphorus in soils. Soil Science. 59:39-45.
2. Daughtrey, Z. W., J. W. Gilliam and E. J. Kamprath. 1973. Phosphorus supply characteristics of acid organic soils as measured by desorption and mineralization. Soil Science. 115:18-24.
3. Mitchell, Wm. W. 1968. On the ecology of Sitka alder in the subalpine zone of southcentral Alaska, p. 45-56. IN Biology of alder, Proceedings of a Symposium. Northwest Scientific Association Fortieth Annual Meeting. Forest Service, U. S. Department of Agriculture, Portland, Oregon.

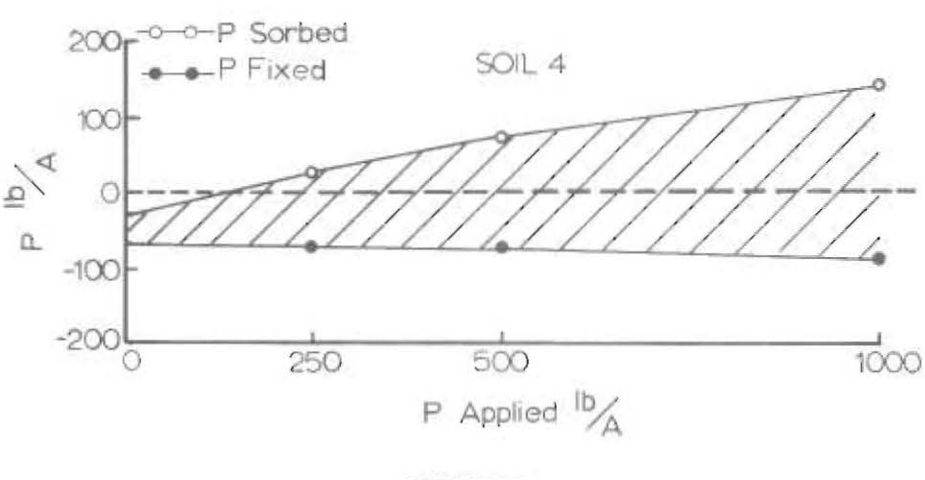


FIGURE 2.

Phosphorus sorption and fixation patterns for soil sampled from alder thicket.

Winter Stresses Affecting Overwintering Crops In The Matanuska Valley

L. J. KLEBESADEL
Research Agronomist

". . . Then the winter fell with a sudden swoop and the heavy clouds sagged low.
And earth and sky were blotted out in a whirl of driving snow."

. . . Robert Service

Northern winters do begin with relative abruptness. Moreover, they are anything but mild, especially to overwintering field crops that must endure for near seven months the rigorous stresses imposed by each subarctic winter.

Some crops don't survive. Others may be so severely winter-injured that either they die after putting forth meager spring growth, or their yield is disappointingly low.

Winterkill of perennial forage crops occurs often enough to be a continuing problem in Alaska. Why? Whether or not overwintering crop plants survive an Alaskan winter depends principally on two major factors—(a) the severity of winter stress to which the plants are exposed, and (b) the extent to which the plant has undergone inner physiological and biochemical changes that cause it to be "prepared" for winter's stresses. To accomplish adequate physiological preparation for winter, plants must be exposed to the appropriate combination of environmental conditions during late summer and autumn (4).

Figure 1. Effectiveness of barley stubble in holding snow layer in place against strong winter winds. Note virtually bare soil to left versus several inches of snow in stubble to right. Height stake is three feet tall.

Beyond these two major factors a number of other considerations also can influence winter survival. These include diseases or poor management practices that weaken plants, position of overwintering plant tissues relative to the soil surface, and damage during winter from small rodents or traffic, to name a few. These factors may assume dominant roles in certain situations but currently are of less general significance in southcentral Alaska than the two major factors listed first above.

The inner, physiological preparation that protects plants from winter stress will be discussed in a future article. This report is concerned with characterization of the external winter environment that affects overwintering crop plants in Alaska, especially in the Matanuska Valley in the southcentral area of the State.

Knowledge of Stresses is Needed

In our agronomic research programs, we seek to reduce or eliminate hazards, such as winterkill, associated with crop production. In order to escape winter damage to crops, we seek to improve their genetic hardiness (5,6), as well as to devise management practices that will not to weaken them to the point where they are susceptible to winter stress. To properly achieve these goals, we should have an awareness of the nature of winter's stresses.

A complex interaction of varying effects prevails during our Alaskan winters. Changing temperatures, presence or absence of snow, ice, and wind, amount of soil moisture — these are some of the major interwoven parameters which create winter stress on plants. Winterkill may result from a single stress factor, or it may be the result of several; the injury or lethal effect may occur at one time, or it may be due to a repetition of the same or different stresses having a cumulative harmful effect.

Snow

Although snow is a somewhat chilling and conspicuous indicator of winter, the direct effect of a layer of snow on farm fields is beneficial to overwintering crops. The principal values of snow are the insulation it provides from cold (or warm) air temperatures, the prevention of moisture loss from plants and soil during winter, and the moisture released as it melts in spring. None of these benefits are realized to maximum potential in much of the Matanuska Valley because winter winds remove much of the snow from fields; moreover, the meltwater from snow remaining in spring often evaporates or is lost to runoff before the soil thaws to admit its entry. One indirect, harmful effect resulting from snow cover is the development of snowmold beneath the snow. These pathogens frequently cause injury or death to some overwintering crops and lawn grasses in the Tanana Valley where snow remains in place until melting in spring; its occurrence is less common in the Matanuska Valley.

Figure 2. An ice pond formed in a field due to melt of winter snow, collection of water in low areas, and refreezing.

The actual effectiveness of snow as an insulator against low temperatures is somewhat surprising (3). An eight-inch blanket of snow can keep temperatures at the soil surface near 30°F when air temperatures are as low as minus 24°F above the snow.

An effective management technique for holding snow in place in fields exposed to winter winds is to leave a tall stubble when crops are harvested (Fig. 1). A 10- to 12-inch barley companion

Figure 3. Perennial grass field in spring showing winterkilled grass in low areas where ice had ponded during winter.

crop stubble will effectively hold a 6- to 10-inch protective layer of snow despite the strongest winter winds; the snow retained can make the difference between successful establishment of a new forage seeding or winterkill of the otherwise exposed seedlings. Leaving a 4- to 6-inch forage stubble during subsequent harvest years also is effective in holding snow.

Winter survival of forage crops in Matanuska Valley farm fields differs quite strikingly from that in nearby roadside habitats. For example, three legumes, ladino and white clover *(Trifolium hybridum* and *T. repens)* and birdvetch *(Vicia cracca)* occur abundantly and thrive along Valley roadsides. There snow cover and matted vegetation provide adequate insulation from low air temperatures during winter. When seed of these species is harvested and planted to establish stands of these legumes in adjacent fields where snow cover does not remain in place, all three species usually succumb to winterkill.

Ice

Ice generally is harmful to overwintering crops. Usually it occurs as ponds in low areas (Fig. 2) but occasionally, as a result of a "freezing rain" or refreezing of thawing snow, ice can form as a sheet covering virtually all of a farm field.

Ice results in winterkill usually through smothering. The impervious ice layer is a barrier to gaseous diffusion, resulting in toxic accumulation of respiratory compounds within plants beneath the ice (7). It follows that the longer ice coverage of plants persists, the greater the harmful effects are likely to be. Figure 3 shows a field in spring, with dead grass where ice ponds were present in low areas during winter.

One protection against the smothering effect of ice is the presence of stubble from a grain companion crop or from a stand of grass or legume; such stubble must be tall enough to protrude above the ice sheet. These hollow plant parts may provide effective ports through an ice sheet for gaseous diffusion vital to the underlying plants. Moreover, emergent stubble results in earlier thawing of ice immediately surrounding the stubble (Fig. 4).

A layer of ice does not provide a beneficial insulating effect as does a layer of snow. Ice has a much higher thermal conductivity than snow; therefore plants beneath are much less protected from low air temperatures by ice than by a snow layer.

The formation of ice crystals in the soil near the surface as a result of repeated thawing and freezing can result in the "heaving" or lifting of tap-rooted legumes. Seedlings are more susceptible to this type of damage than are older plants. When elevated above the soil surface, the exposed plant crowns are much more susceptible to freezing and dessication injury. Such heaving of plants is more prevalent in clays and silts than in sandy soils.

Winds

Two major, relatively mono-directional winds occur sporadically during winters in the Matanuska Valley. Both winds are generated by strong pressure gradients aligned with river valleys. The genesis, characteristics, frequencies, and durations of each are described elsewhere (2). The most prevalent is the "Matanuska" wind, so-named because of its approach through the gorge of the Matanuska River, a water and air drainage channel from Interior Alaska between the Talkeetna and Chugach Mountain Ranges.

These cold winds blow sporadically from the northeast, often with considerable velocity. Their significance to overwintering field crops lies mainly in two phenomena — (a) removal of protective snow cover, and (b) a dehydrating effect deleterious to exposed plant tissues. Moreover, sublimation of ice and snow affects the hydrologic balance negatively in an area already marginal in moisture supply (1) and, with the wind, contributes to winter erosion of wind-dried surface soil.

The other prevalent winter wind blows from the southeast and raises air temperatures to between 40° and 50°F. This wind originates on the warmer Gulf side of the coastal mountains and enters the Valley down the Knik River Valley. These "Knik" winds also are sporadic, occurring one to several times during some winters (e.g., 1969-1970) and not at all during others (e.g., 1972-1973). Moreover, their duration varies from a few hours to several days.

Of significance to overwintering plants is the duration of the winds and the snow cover present during their occurrence. When plants have entered a state of dormancy or rest for the winter period, they fare best if temperatures remain sublethally low and relatively constant during the winter period (7).

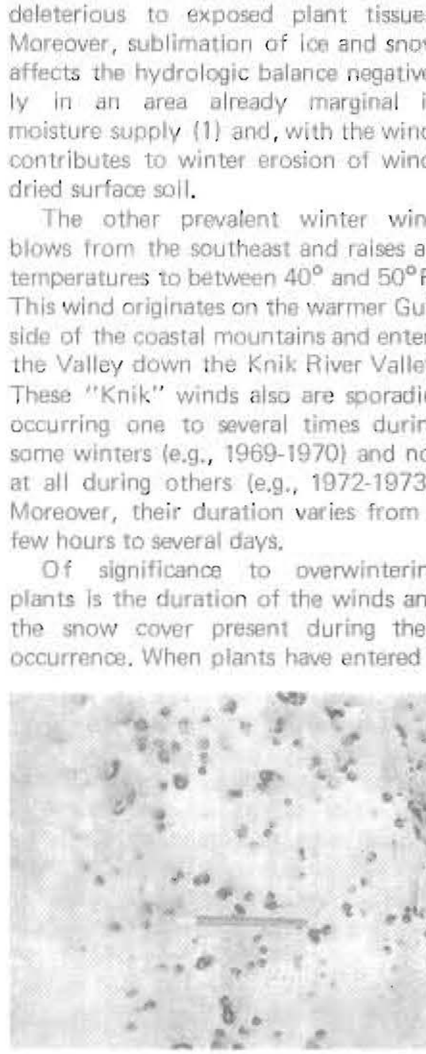


Figure 4. Sheet of ice in field showing thaw holes surrounding stubble that was emergent through the ice sheet.

If snow cover is present, a short-duration Knik wind merely "settles" the snow. Harmful effects derive from longer-duration winds that thaw snows to refreeze in place as ice sheets or as ice ponds in low areas. If no snow was present at the start of a warm wind, or if all snow melted, the surface layer of soil may thaw. This has a damaging effect on overwintering crop plants.

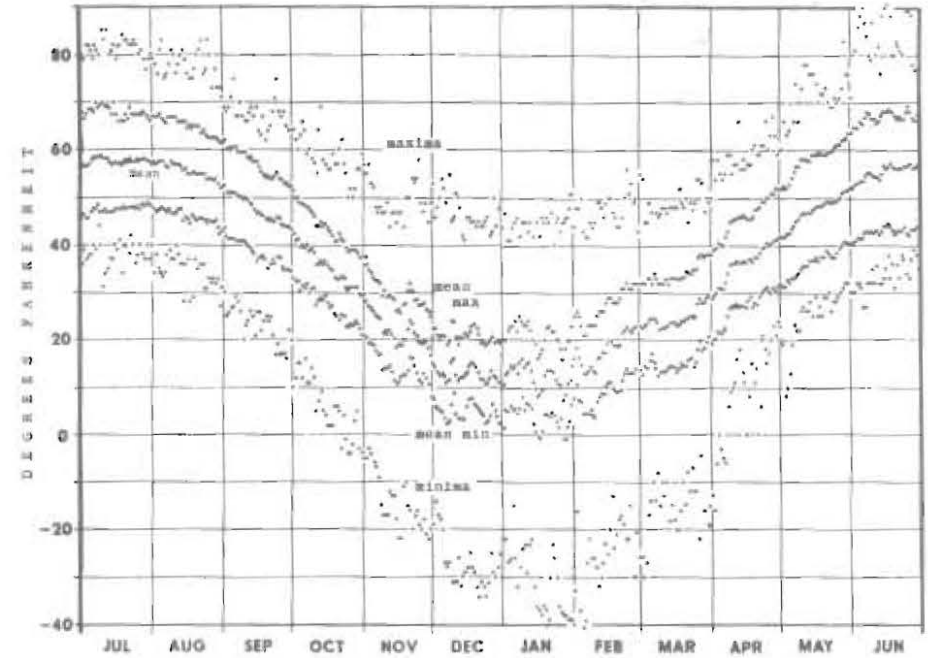


Figure 5. Annual temperature pattern derived from forty years of data recorded at the Matanuska Research Farm. Dots showing maxima and minima represent highest and lowest temperatures recorded for each day over the forty-year period. Daily mean, mean maximum, and mean minimum are presented also.

Both winds then can reduce the generally desirable snow cover on fields, the Matanuska winds driving the snow away, or the Knik winds melting the snow in place. From the standpoint of field crops, one compensation derived from snow removal by winds during winter is an effective lengthening of the following growing season. The bared soils in the Matanuska Valley absorb heat sooner in spring promoting earlier growth of crops than in the nearby Susitna Valley where the usually deep snows must melt in place. However, these bared soils freeze more deeply and require more heat to thaw than do those soils in the Susitna Valley where little frost penetration occurs through the heavy snow cover.

The degree of exposure in the field to prevailing winter winds can have a marked effect on survival of crops. This may vary with location in the Valley, it may even differ considerably within a very localized area. For example, in an earlier study (5) the same alfalfa row test was planted at two locations in the same field at the Matanuska Research Farm. One planting was to leeward of a wooded tract that protected rows from strong winter winds that otherwise would have removed snow cover; the other planting was unprotected from winter winds. The 36 alfalfa varieties averaged only 33% winterkill in the protected site, but 90% died in the unprotected planting.

Temperature

Some insights into winter temperature conditions in the Matanuska Valley can be derived from the graph, based on forty years of data, in Figure 5. It should be noted that this illustration was prepared from data recorded at the Matanuska Research Farm and represents conditions at one site only. Throughout the Matanuska Valley, winter temperatures at any given time may differ considerably among different recording stations, the lower topographic sites usually recording the lowest temperatures when weather is calm. However, the general temperature pattern in Figure 5. is characteristic of most of the Valley.

Relatively warm (40° to 50°F) temperatures can occur during any of the winter months (Figure 5). These temperatures result when climatological conditions bring warm Knik winds into the Valley from the southeast (2).

Matanuska Valley soils usually freeze during October; during that month the mean temperature descends from about 40° to 30°F. The lowest temperatures recorded at the Matanuska Research Farm have occurred during the latter half of January or in early February, about one month after the winter solstice (December 21). The lowest recorded over the 40-year span are at or near minus 40°F.

A curious undulating pattern is discernible during winter in the mean temperature tracks (mean, mean minima, mean maxima) in Figure 5. A relatively smooth trend of lowering temperatures prevails throughout late summer and autumn until about mid-November. Thereafter, until late February or early March, a sequence of temperature rises and falls is evident. For this cyclic series to be identifiable in a track of 40-year means indicates that the phenomenon is more regular than random in occurrence. The specific cause of this pattern is not clearly understood.

Conclusions

What specific stresses cause winterkilling of crops? At this point we do not know precisely. More investigation will be required to determine the answer with certainty. Certain tentative conclusions can be drawn, however.

Some insights can be gained by comparing records of stress factors from winters that caused widespread winterkill with those from winters that caused little damage to crops. Two of the most damaging winters in the past two decades were those of 1956-57 and 1961-62. Daily maximum and minimum temperatures for both are plotted in Figure 6. For comparison, a winter of less than average stress, as measured by crop survival, was that of 1960-61 (Fig. 7). More precise information on the specific temperatures acting directly on overwintering plants would be available from temperatures recorded at the soil surface rather than these recorded 4.5 feet above the ground (3); however, those are not available from the various agronomy field studies from which winter survival data were taken.

Certain information is apparent from the temperature records. Considerable oscillation of temperatures is noted during the months of November through March in all three winters. Lowest temperatures were recorded in 1961-62. The mildest winter, 1960-61, showed little occurrence of temperatures below minus 10°F, and those for very brief duration.

In general, it can be seen that the most damaging winters show more extreme oscillation of temperatures with definite occurrence of relatively rapid "plunges" from mild air temperatures to lethally low levels. Not only do the minima reach quite low levels but the maxima also remained very low for four to six days in December of both years.

A precipitous drop in air temperature

from above freezing to very low levels would be most damaging to overwintering crops if it occurred when no protective layer of snow was present. This situation could prevail (a) if no snow had yet fallen (in one winter, no appreciable snow fell until the last days of December, (b) if Matanuska winds had blown the snow from fields, or (c) if a prolonged duration of warm Knik wind had melted the snow.

Additional studies are needed to document more thoroughly the interaction of winter's stress factors, especially at the microclimatic level. Measurements immediately adjacent to plant tissues will characterize winter stresses actually experienced by overwintering crops. Through a better understanding of the specific causes of winterkill, we will be better able to cope with this hazard to crop production. □

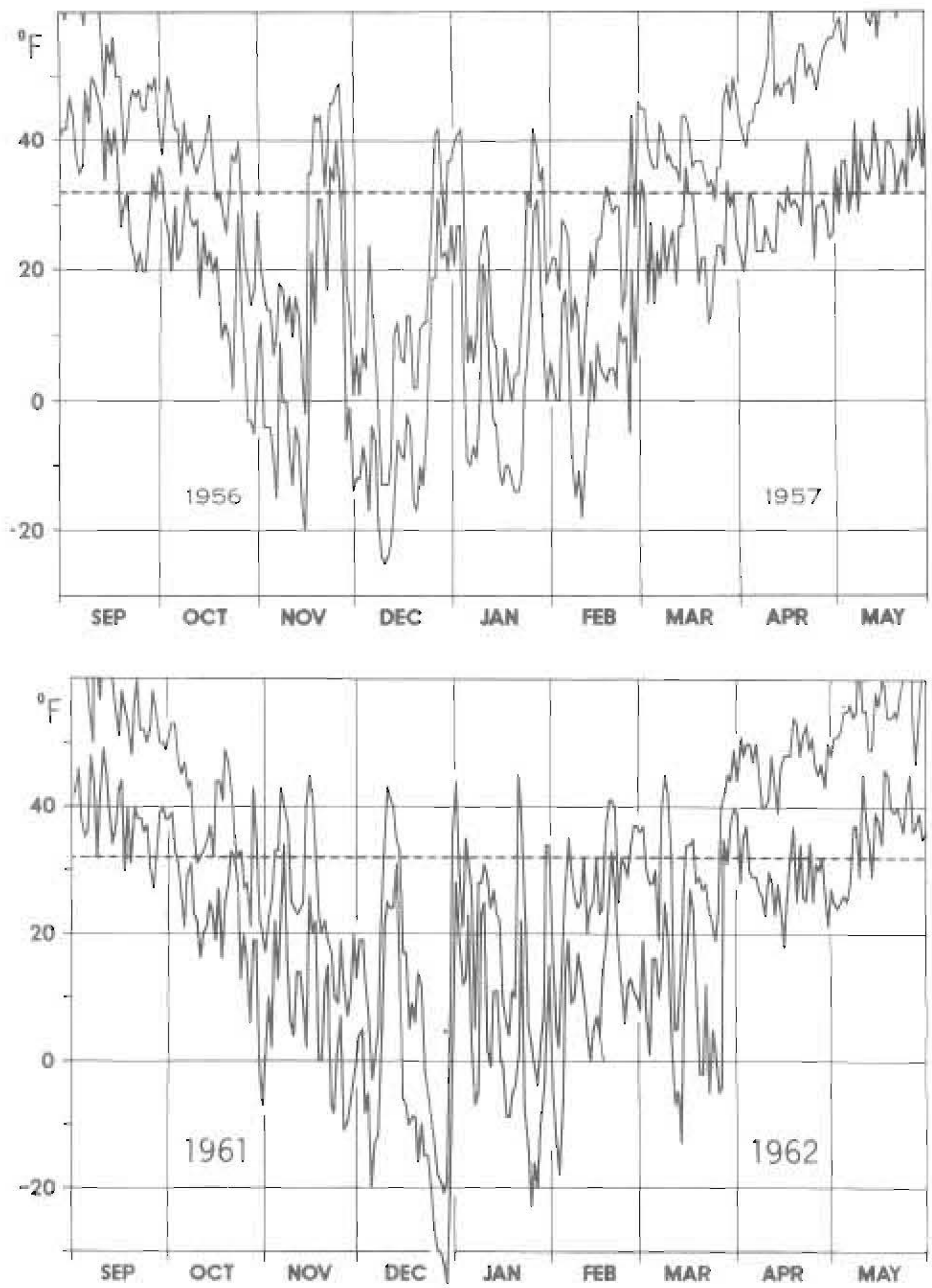


Figure 6. Daily maximum and minimum temperatures recorded at the Matanuska Research Farm during two of the winters most damaging to overwintering crops during the past twenty years.

REFERENCES

1. Branton, C. I., L. D. Allen, and J. E. Newman. 1972. Some agricultural implications of winter sublimation gains and losses at Palmer, Alaska. Agricultural Meteorology. 10:301-310.
2. Dale, R. F. 1956. The climate of the Matanuska Valley. U. S. Department of Commerce Technical Paper 27. 26 pp.
3. Kinbacher, E. J., and N. F. Jensen. 1959. Weather records and winter hardiness. Agronomy Journal. 51:185-186.
4. Klebesadel, L. J. 1971. Nyctoperiod modification during late summer and autumn affects winter survival and heading of grasses. Crop Science. 11:507-511.
5. Klebesadel, L. J. 1971. Selective modification of alfalfa toward acclimatization in a subarctic area of severe winter stress. Crop Science. 11:609-614.
6. Klebesadel, L. J., and R. L. Taylor. 1972. New Alaskan grasses excel in winterhardiness. Agroborealis. 4(1):9-10.
7. Smith, Dale. 1962. Forage management in the North. W. C. Brown Book Co., Dubuque, Iowa. 219 pp.

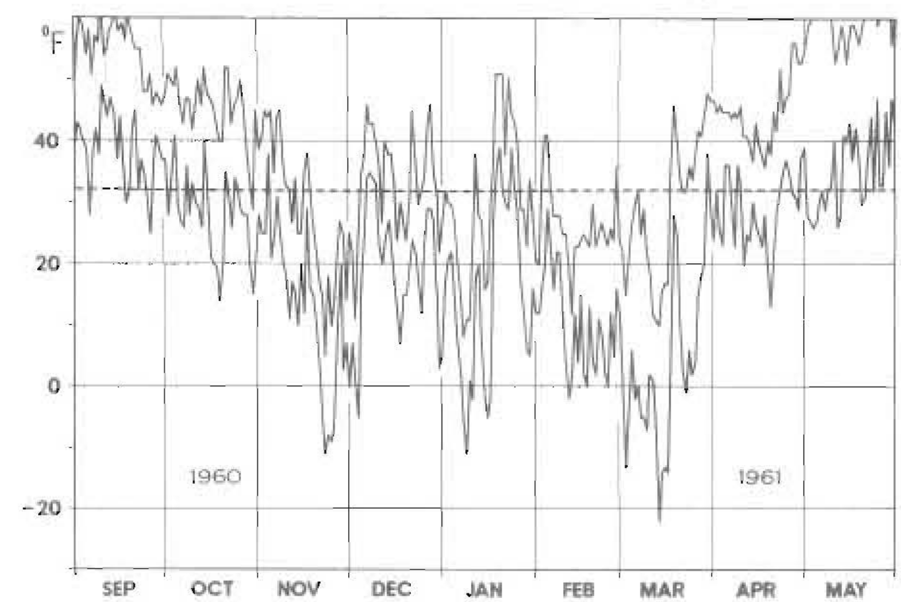


Figure 7. Daily maximum and minimum temperatures recorded at the Matanuska Research Farm during one of the winters least damaging to overwintering crops during the past twenty years.

Native Bluejoint: A Valuable Forage And Germplasm Resource

WM. W. MITCHELL
Professor of Agronomy

In some agricultural areas of Alaska, grass-covered sod does not thaw until mid-May to early June. Such soils awaken and produce new growth when the sun approaches its zenith, providing from 16 to over 20 hours of photosynthetic activity. A grass, to be useful as a forage species, must exploit these long days within a short period of time. Furthermore, in some areas grasses must tolerate strongly acidic soils that remain cool through much of the growing season. This is particularly true where a constant grass cover builds up a thick insulating layer of litter and mulch. Few grasses are adapted to grow well under such conditions. Native bluejoint reedgrass appears to be admirably suited to such a regime.

Bluejoint reedgrass *(Calamagrostis canadensis)* occurs through much of the boreal and north temperate regions of the continent, but is at its luxuriant best in Alaska. Often one of the dominants, and sometimes the predominant growth in herbaceous plant communities, bluejoint is probably the most abundant grass in Alaska. It is particularly important in the vegetative economy of southcentral and southwestern Alaska where dense stands occur on lowland to upland sites. The grass provides grazing and harvestable forage for stock growers in these regions. Bluejoint also invades and stabilizes disturbed areas. It is sometimes referred to as redtop in local terminology but should not be confused with a bentgrass (genus *Agrostis*) that more properly bears that common name.

A two-faceted research program is underway at the Institute of Agricultural Sciences to determine how best to utilize bluejoint. First, management procedures are being investigated by various workers. Second, a better understanding of the nature of the species is being sought in order to select superior performing types. Bluejoint is a complex species consisting of a number of races in Alaska (5), and differences in habits and productivity of the various races are being studied.

Bluejoint Responds to Fertilizer

The dense stands of bluejoint found in Southcentral Alaska occur on cleared areas in the forested region and in a subalpine belt above timberline (4). Soils under bluejoint are moderately to strongly acidic, often ranging from pH 3.5 – 5.5. Bluejoint attains heights of 3.5 ft. to over 5 ft. within a six-week growing period (Fig. 1). Yields of 1.5 tons to 2.5 tons per acre (dry matter) have been estimated in native, undisturbed stands of bluejoint (6,7).

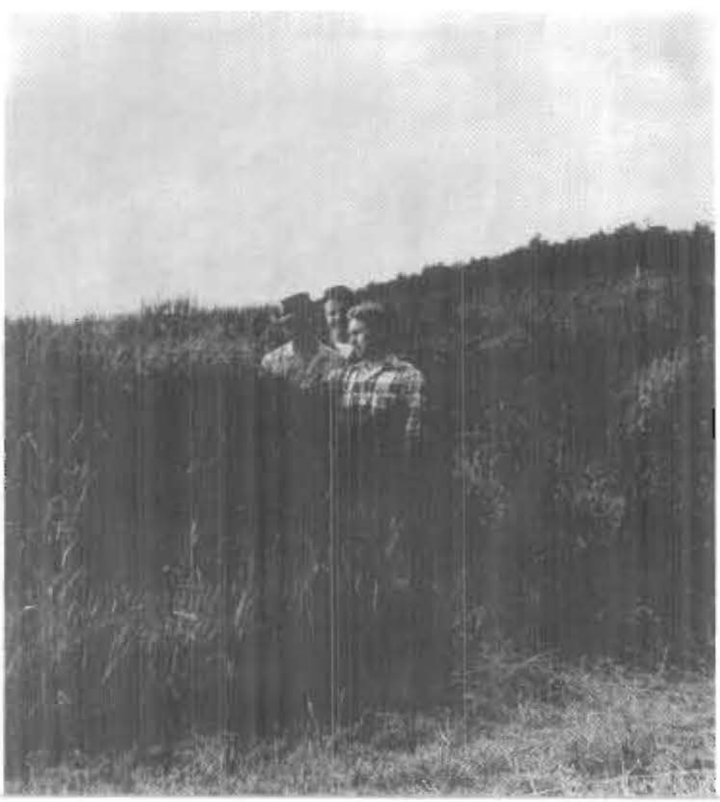
In previous research conducted in the Matanuska Valley (1,2,3), yields of one to two tons per acre have been sustained on harvested plots under various fertilizer treatments. Fertilizer applications ranged from about 400 to 700 lb per acre, using mixes supplying all three major nutrients (nitrogen, phosphorus, and potassium). Over 500 lb of fertilizer were required to produce over 1.5 tons of forage per acre. With fertilization, crude protein contents of forage harvested in early July varied from about 12% to 20%. Yields and protein content were much less without fertilization.

Similar research was begun in 1968 on the lower Kenai Peninsula where extensive bluejoint stands have attracted a small beef ranching industry. Fertilizer was applied in a number of different combinations and at different levels under both one-harvest and two-harvest systems. Results have been somewhat frustrating in that no optimum combination or rate of fertilization has been determined. However, a complete fertilizer, such as 10-20-20, applied at 250 to 300 lb per acre has been adequate to produce yields of 1 – 1.5 tons of dry matter per acre in a one-harvest system. Applications up to about 500 lb per acre failed to raise yields to any appreciable extent during the initial years of the trials. In 1973, however, 500 lb per acre brought production to nearly 2 tons per acre (Fig. 2). Without fertilization, yields generally have ranged from .5 – .75 tons per acre over the course of the study. Protein contents increased from 9-12% in the initial year of the project to 15-20% in the subsequent years.

Yields of 1 to 2 tons are thus obtainable in the Matanuska Valley and lower Kenai Peninsula with relatively low to moderate applications of fertilizer. Annual fertilizer applications increase yields and the quality of the forage, having an apparent cumulative effect. Work is continuing to find fertilizer combinations and sequences that may raise yields more economically.

Superior Breeding Stock Sought

The second area of research also holds promise for increasing production.



Bluejoint grows rapidly under the long daylight regime of early to mid-summer. By mid-July it may achieve heights of 5 to 5.5 ft. Here bluejoint has reinvaded an area previously used for experimental work on the Jack Epperson ranch north of Homer on the Kenai Peninsula.

Experimental bluejoint plots fertilized annually for the last four years produced a high quality forage at about 2 tons of dry matter per acre. The foreground portion, which has remained unfertilized, yielded at less than half that rate. The plots are being sampled here to obtain material for yield estimates and for analysis of forage quality.

The highly variable population occurring throughout the state represents a germplasm (genetic) resource from which superior breeding types may be selected.

Collections of bluejoint have been made in a number of different locations throughout the state. Cytological work with these collections has determined that the species consists of three different chromosome races.

Species of animals tend to hold true to one chromosome number. Man has 46 chromosomes in the nucleus of his cells. The horse has 66. Any major divergence from these numbers produces an imbalance in the genetic material and causes abnormalities.

Plant species are not so strict in adhering to a particular chromosome number. Some species consist of different chromosome races that are multiples of a particular base number. In Alaska, bluejoint consists of races with 28, 42, and 56 chromosomes (5). There is some pattern in how these races are distributed in the state. Plants with 28 chromosomes make up the dense stands of bluejoint in the southcentral and southwestern regions of Alaska (Fig. 3). In the southcentral region, those with 42 and 56 chromosomes have been found only at the higher altitudes, whereas in the interior regions, 42-chromosome plants are frequently found along with 28-chromosome plants. Plants with 56 chromosomes are rare in the Interior. On the North American continent, the 28-chromosome race has been found only in Alaska. The 42- and 56-chromosome races occur in Canada and in parts of the conterminous United States.

These differences in chromosome numbers result in some trait differences. Furthermore, populations vary in adaptive characteristics from region to region, and individuals within a local population are not identical. Thus, the total Alaska bluejoint population represents a complex, highly variable gene pool from which to make selections.

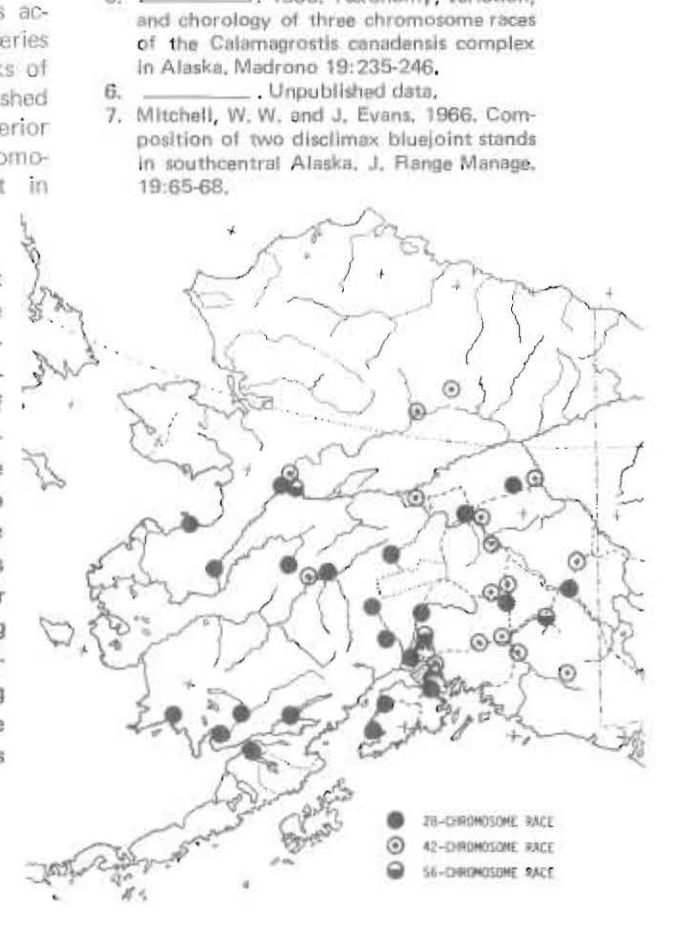
Comparisons in productivity are now being made among collections from a large number of locations. This is accomplished in spaced-plant nurseries and row plantings. Breeding blocks of the best performers will be established to promote the production of superior progeny. An understanding of chromosomal composition is important in establishing breeding blocks, because crossing is much more possible among members of a given race than between members of different races. These results will indicate which populations and localities might be most suitable for future collections. Seed for further field trials will be obtained from plantings of the more promising materials in seed-increase plots.

This two-pronged research attack—studying management procedures on existing stands and developing improved genetic stocks—should provide increased production where bluejoint is used as a forage crop. Bluejoint also may be used to rehabilitate disturbed ground where native species are desired as a cover. □

REFERENCES

1. Klebesadel, L. J. 1965. Response of native bluejoint grass (Calamagrostis canadensis) in subarctic Alaska to harvest schedules and fertilizers. Proc. IX Intern. Grassl. Congr. 2:1309-1314.
2. Klebesadel, L. J. and W. M. Laughlin. 1964. Utilization of native bluejoint grass in Alaska. Alaska Agric. Exp. Sta. Forage Res. Report 2. 22 p.
3. Laughlin, W. M. 1969. Nitrogen, phosphorus, and potassium influence yield and chemical composition of bluejoint forage. Agron. Jour. 61:961-964.
4. Mitchell, W. W. 1968. On the ecology of Sitka alder in the subalpine zone of southcentral Alaska. Proceedings Symposium, Biology of Alder, publ. by U.S.D.A. Pac. Northw. Forest and Range Exp. Sta., Portland, Ore. 45-56.
5. ———. 1968. Taxonomy, variation, and chorology of three chromosome races of the Calamagrostis canadensis complex in Alaska. Madrono 19:235-246.
6. ———. Unpublished data.
7. Mitchell, W. W. and J. Evans. 1966. Composition of two disclimax bluejoint stands in southcentral Alaska. J. Range Manage. 19:65-68.

Bluejoint consists of three different chromosome races in Alaska. The map depicts their distribution according to counts obtained on collections made throughout much of the state. The southcentral to southwestern portion is dominated by the 28-chromosome race, the other two races having been found only at the higher altitudes in this region (as indicated). Inland in the Copper River Valley and northward along the Yukon River system the 42-chromosome race is important along with the 28-chromosome race. The 56-chromosome race is rare in this portion of Alaska.



BEEKEEPING IN ALASKA

RICHARD H. WASHBURN
Research Entomologist

Interest in beekeeping in Alaska increases each year. Any decrease in the current level of beekeeping activity that might occur would more likely result from a scarcity of bees than from a lack of interest on the part of Alaskans.

One reason for this enthusiasm is that the market outlook for locally produced honey is much greater than present production. No Alaskan honey is found among the many brands on the shelves of the supermarkets. They carry mostly honey produced and packaged in the western United States. The only known retailer of locally produced honey in the state purchases honey each year and packages it in small jars in gift packages mainly for use in Christmas gift packages. Beekeeping would therefore seem to offer a good opportunity for supplemental income, but so far no one in Alaska has been able to rely on beekeeping as the sole source of income.

Most of the present beekeeping in Alaska is centered in the Tanana Valley near Fairbanks, partly because favorable temperature, daylength, and precipitation exist there. However, much credit should also be given to Roland Kaven, recently retired district agent of the Cooperative Extension Service, who had prior experience in one of the beekeeping areas of Michigan. He was able to point out the advantages of beekeeping to many of the local residents, and the interest he engendered still persists. Indeed, the Tanana Valley is the only area of the state in which beekeeping supplies are available locally.

Although most of the estimated 600 packages of bees shipped into Alaska each spring go to the Tanana Valley, some beekeepers are found in other parts of the state, including such diverse areas as Haines in Southeast Alaska, Kodiak Island, the Kenai Peninsula (especially near Homer), Anchorage, and the Matanuska Valley. There is also rapidly expanding interest in the Copper River Valley where the second largest operation in Alaska (about 40 colonies) will be located in 1974, an expansion from 26 colonies in 1973. The largest operation at Fairbanks has about 90 colonies.

Usually small (1 to 3 package) shipments of bees are sent to Alaska by air parcel post; larger shipments arrive by air freight. However, in recent years, quite reliable service has been obtained by using parcel post to Seattle and then by air freight to either Anchorage or Fairbanks. Since small air freight shipments to outlying areas are often assessed several minimum-rate charges, air parcel post is reasonable in comparison.

Apiary of John Bohm, Homer, Alaska. This colony produced 332 pounds of honey in 1962, which is the present Alaskan record.

Package bees are shipped in early May, usually three pounds of workers and a queen plus a can of syrup to sustain the bees enroute. Shipments should always be made at the first of the week to avoid weekend delays enroute, since any period spent in a hot storage area may result in high mortality. In Alaska, natural forage ordinarily is not available until early May. Then it is available in early blooming plants suitable for brood rearing, such as willows and dandelions. If the beekeeper already has frames that are partially filled with pollen and honey, it is not necessary to supplement with pollen substitutes and sugar syrup until an adequate supply of natural forage is available. However, an adequate supply of medium-depth supers with frames should be available because crowding is one cause of swarming.

Italian bees are the race most used in Alaska; they are more docile and less prone to sting than some types of bees. They are apt to swarm, however, depleting colony strength, unless the swarms are captured and reunited. Hives should be examined at least once a week. If inadequate brood is present, a new queen may be needed. Queen cells should be destroyed as located.

Honey production, the primary aim of most Alaskan beekeepers, has ranged from almost nothing to as much as 332 pounds from a two queen, 14-super colony at Homer. The usual Alaskan beekeeper is likely to obtain from 20 to 50 pounds, but a few will obtain 100 pounds in a favorable year.

Although fireweed thrives in much of Alaska, it is rarely a good source of nectar for domestic bees. Native bees such as bumblebees and vespoid wasps do frequent fireweed every year, but only in an occasional season will conditions occur that are necessary for fireweed to produce nectar suitable for honey bees.

Various species of clover are a main source of Alaskan honey as in other states. Other good sources are roses, raspberry, asters and numerous wildflowers. Chickweed is often utilized by honey bees after a series of frosts when other nectars are no longer available. Dandelions are a favorite pollen source wherever found in Alaska. Temperature is quite critical in production of nectar. In the Copper River Valley in 1973, hives located in the middle of several acres of alsike clover in full bloom were rarely able to obtain nectar because it was too cold for proper secretion except on a few occasions.

Although most Alaskan beekeepers are mainly interested in the production of honey, honey bees are a valuable supplement to native bees in pollinating cultivated crops. Plant materials that benefit from honey bee pollination include squash, cucumber, raspberries, strawberries, crabapples, and apples.

Production of legume seed is benefited by honey bees although with alfalfa the bees do not like being hit in the face when the keel of the flower is tripped, therefore, the bees may learn to get nectar without tripping. Nevertheless, in the agronomy greenhouse at the Palmer Research Center, utilization of captive honey bees has promoted sufficient alfalfa seed production to make their use worthwhile in spite of this problem.

Many of the species of solitary bees that are native to Alaska are present for only a limited period. However, bumblebees are active throughout the flowering period of most plants and they work longer hours. For example, they may work raspberries until 11 p.m., while honey bees retire to the hive around 6 p.m.

Chemical analysis of Alaskan honey has shown it to be somewhat different in content than honey produced in the more southerly states. Details are given elsewhere (1). The major differences are that Alaskan honey is less acidic and is lower in sucrose but higher in maltose and the more complex sugars.

In areas of the state where bears are a problem, a fence should be placed either around or completely over the hives. Once bears realize that honey is available, they will return to finish off the hives and will completely destroy the frames and sometimes the supers. Any bees that survive will be so demoralized as to be useless.

Because of the long winters, with relatively few thaws, honey bees are usually disposed of when the cells are capped in the fall. It is possible to wrap the hives and to feed the bees through the winter but this will usually require more sugar and supplements than it is worth, and the colony may be dead or so weak as to be useless by spring. Also, there are never thaws of sufficiently high temperatures so the bees can fly in early spring as in other parts of the United States.

When the bees are to be destroyed (with calcium cyanide), regulations require that the honey be removed first if it is to be used for human consumption. The easiest way to remove the bees is with a bee-escape, or with a stream of air from a blower or tank-type vacuum cleaner.

After the frames are uncapped the honey is removed by using an extractor. If an extractor is not available, the foundation containing the honey is cut out and eaten as cut-comb honey, or small quantities can be carefully warmed in the top of a double-boiler until the wax melts and floats on top. However, the warming must be done very carefully because the honey carmelizes readily, producing an undesirable flavor. Also, comb honey can be squeezed through a cloth sack, but that is rather messy, and the method seldom extracts all the honey.

Extracted honey sometimes solidifies because it is stored at too low a temperature, or, occasionally, because the nectar sources were such that they produce a honey that crystallizes readily. Honey that solidifies is easily liquified by carefully warming in a container in a pan of water. □

REFERENCE

1. Washburn, R.H. 1961. Beekeeping in the Land of the Midnight Sun. Gleanings in Bee Culture. Vol. 89 (12).

Barley Response To Phosphorus And Lime

WINSTON M. LAUGHLIN
Research Soil Scientist

Barley produced very poor growth on Tustumena silt loam on the farm of Mrs. Walter Bremond near Soldotna on the Kenai Peninsula. Barley plants were stunted, rarely tillered, lower leaves were dying to yellow, heads were small and grain yields very low.

In July 1968 we were invited to investigate the problem to determine if the poor growth were related to inadequate nutrition. Much of the organic matter from the surface six inches of soil had been pushed into berm piles during clearing. Studies in 1968, 1969, and 1970 were uniformly discouraging because of grazing by cattle and horses and damage from a weed control spray.

In 1971-72, another field experiment was established involving seven phosphorus rates (0, 40, 80, 120, 160, 200, and 240 lb P_2O_5 per acre), with and without lime, to determine if yields could be increased. Lime was applied at the rate of five tons per acre to the appropriate plots in September 1971 and worked into the soil with a rototiller. From the time of application to the end of the 1972 growing season, lime reduced the soil acidity from pH 5.3 to pH 6.2 (1:2 water). On June 5, 1972 the phosphorus was applied to the soil surface along with 80 lb of both N and K_2O per acre, the area was rototilled, and five rows each of Edda and Weal barley were planted across each plot.

The Edda barley was cut and placed in cloth sacks September 19 and Weal barley was harvested similarly the following day. After being transported to Palmer and dried indoors, grain from each plot was threshed, cleaned, and weighed.

Figure 1 shows general appearance of the barley and response to both lime and high phosphorus treatments. Figures 2 and 3 present yields graphically for Weal and Edda varieties, respectively. The length of the line section labelled 5% L.S.D. (least significant difference) represents the distance on the graph's vertical axis for a statistically significant difference at the 5% level of probability.

Each phosphorus increment up to 120 to 160 lb P_2O_5 per acre tended to increase the grain yield of both varieties. The rate of this increase tended to be greatest between 120 to 200 lb P_2O_5 per acre. Averaged over all treatments, Weal barley outyielded Edda by nearly 30%. Fertilizing with at least 120 lb per acre promoted tillering and produced dark green plants with wide leaves. Liming further enhanced the vigorous appearance.

The lime application at five tons per acre increased yields of both barley varieties. The increase resulting from lime was more pronounced with Edda than with Weal. With both varieties, the increase in grain yields from liming tended to be greatest at phosphorus fertilization rates between 40 and 120 lb per acre.

The Tustumena series consists of well-drained soils developed in a moderately deep deposit of wind-laid silty material underlain by water-worked sand. These soils occupy broad terraces along the Kenai and Kasilof Rivers and are closely related to the Soldotna series. Both of these soils cover extensive areas on the Kenai Peninsula. These results will apply to most of these soils, especially where much of the surface organic mat was removed in clearing.

These soils will require at least 120 to 160 pounds of P_2O_5 per acre for successful barley production. Yields could be increased further by liming the soil. However, for this to be practical the lime would have to be obtainable at a reasonable cost. □

Figure 1. Edda barley near Soldotna (July 22, 1969). Left: 240 lb P_2O_5 per acre and lime; right: 80 lb P_2O_5 per acre with no lime.

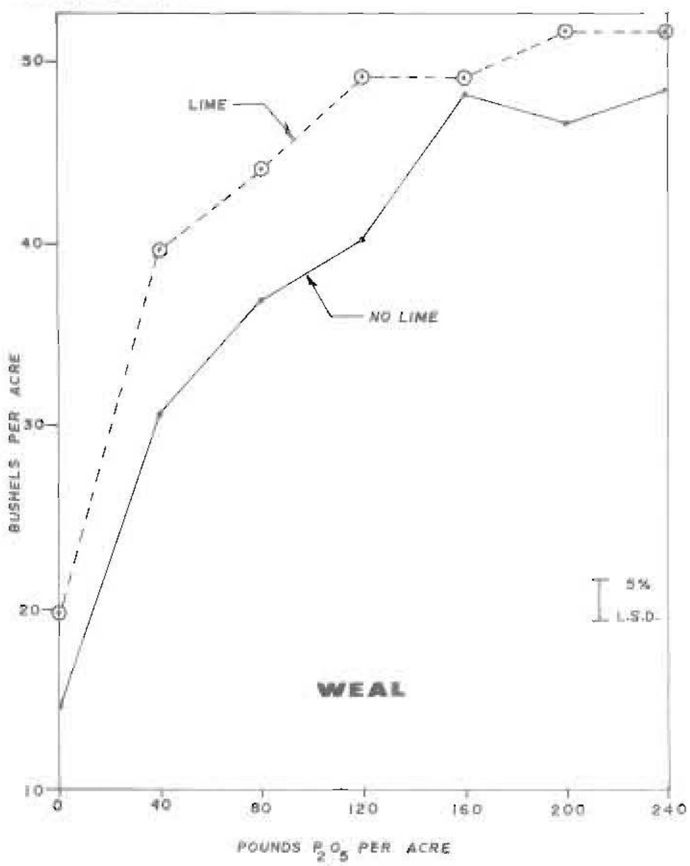


Figure 2. Effect of phosphorus and lime on Weal barley yield, 1972.

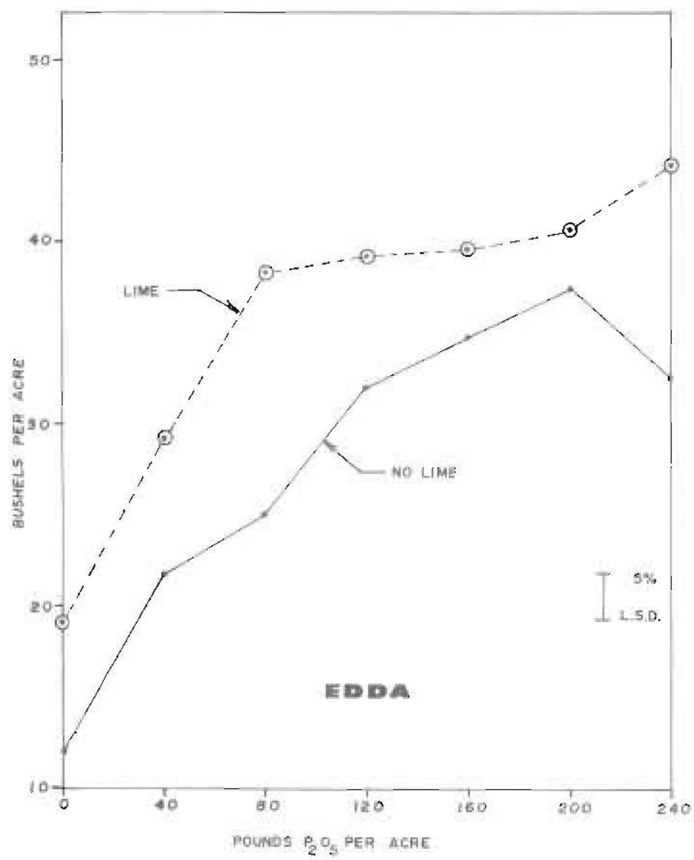


Figure 3. Effect of phosphorus and lime on Edda barley yield, 1972.

A Super Bird's Eye View Of Alaska

JAY D. McKENDRICK
Assistant Professor, Agronomy

and

PETER C. SCORUP
Agronomy Technician

Hidden among Alaska's vast land resources are many areas suitable for various agriculture uses including cropland, livestock grazing, and timber production. These latent agricultural areas are relatively few in number when compared to Alaska's 375 million total acres. They are therefore precious lands not only to the state but also to the nation and to a world with growing food and forest product shortages. Historically, land use decisions unfavorable to agriculture have rarely been reversed, and uses incompatible with agriculture often destroy the natural production potentials of the land.

Land-use problems are increasing not only throughout the conterminous United States, but also in Alaska. Subdivisions and urbanization probjects are diminishing prime agricultural lands, recreational uses are given priority over livestock grazing and timber management programs, and agricultural uses of lands unsuited for farming have proven to be costly mistakes. It is possible to observe in other states those nineteenth-century mistakes, and we must avoid committing such errors in the development of Alaska.

A parable was given nearly 20 centuries ago:

> *"For which of you, intending to build a tower, sitteth not down first, and counteth the cost, whether he have sufficient to finish it? Lest haply, after he hath laid the foundation, and is not able to finish it, all that behold it begin to mock him, saying this man began to build and was not able to finish." (Luke 14:28-30).*

We might apply that lesson today to the present land situation in Alaska: 'For which of you charging your governments, their agencies and commissions to guard your land resources, would ask them not to sitteth down first and counteth the cost of their decisions, whether the same be too great for the people to bear? Lest haply, after the irrevocable decisions are made, all that learn of them begin to mourn, saying, our prime forests and farmlands have been given to those who valued them not, now houses and highways sitteth on our prime lands and our monies are wasted on efforts to drain swamps and fertilize poor soils for the growing of grain and trees. Woe, the cost is too great, for our wives and children do hunger and shiver; and the wilderness comforts them not. As a prosperous and secure people we are surely finished.'

Counting the costs (weighing alternatives) of land use and management decisions presupposes the availability of adequate resource inventories. For example, consider the Matanuska-Susitna Borough, 23,000 square miles, an area slightly smaller than the state of West Virginia (24,181 square miles). There are many potential uses for land within the boundaries of that borough. Major land ownership within the borough currently is divided as follows: private 2%; borough 3%; state 27% and federal 68% (4). An orderly development plan would necessarily be built around a map of land use potentials, and major ownership boundaries, and would include provisions for all feasible uses from farming to "esthetics."

Adequate inventories should answer such pertinent questions as: where are the most productive hardwood and softwood forests, potential and existing croplands, domestic livestock and wildlife ranges? Where are the scenic beauties and best outdoor recreation sites? Who owns such lands? Where are the lands with the least potential for cultural development? Are there sufficient acres for developing certain enterprises such as truck farming, lumbering, and range livestock operations? Although this listing was not intended to be a comprehensive array, the answers to even these questions would greatly assist planners, resource managers, potential entrepreneurs and financing organizations.

Accumulating detailed land resource information for large areas with conventional methods is a huge and expensive task, often exceeding $1000 per square mile (sq mi) and requiring years to complete. For large undeveloped areas, such as Alaska, the most effective efforts would be first to determine generalities of the total area and then focus intensive efforts on areas which were discovered to contain high priority resources such as commercial forests, potential agricultural lands, etc., depending upon specific management needs and objectives.

The potentials of remote sensing from satellites appear to have promise for determining generalities for vast land areas (1). As participants in the University of Alaska's interdisciplinary Earth Resources Technology Satellite (ERTS-1) program (2), members of the Institute of Agricultural Sciences' staff have been investigating the use of satellite sensing to help identify land having potential for agricultural uses. The National Aeronautics and Space Administration (NASA) provided funding and data for the study.

The project's objectives include use of ERTS data for mapping Alaskan vegetation types. Plant ecologists have learned that natural vegetation can be used to interpret existing environmental factors. Thus, maps showing the distribution of natural vegetation types and soils would graphically portray the land resources and hence constitute the basis for a land resource inventory.

Satellite Findings

Findings from the ERTS-1 project indicate that Alaskan vegetation types can be mapped through satellite sensing, not only for large regions at a reasonable cost, but also at various scales. We have been able to map vegetation at 1:18,800 (1 inch = 0.296 miles), 1:63,360 (1 inch = 1 mile) and 1:250,000 (1 inch = 4 miles) scales with 75% to 90% classification accuracy.

Figure 1 shows an example of automated classification of ERTS-1 multispectral scanner (MSS) data for an area near Fairbanks. On the original map (scale 1:18,800) each letter or character represents a single resolution element (picel) in the digital data and is equivalent to about 0.9 acres on the ground. Thus, acreage for various vegetation types can be estimated simply by multiplying picel totals by 0.9. A picel, or picture cell, can be thought of as a transmitted bit of information recorded by the satellite's multispectral scanner. The data are actually measurements of radiation intensities in portions of the visible and invisible regions of the electromagnetic spectrum which were reflected over 500 miles from objects on earth to the sensors on board the satellite.

Notice how closely the classified ERTS data compare with the timber type map which was constructed in 1967 by the Forestry Section of the State Division of Lands for the 23 sq mi Bonanza Creek Experimental Forest

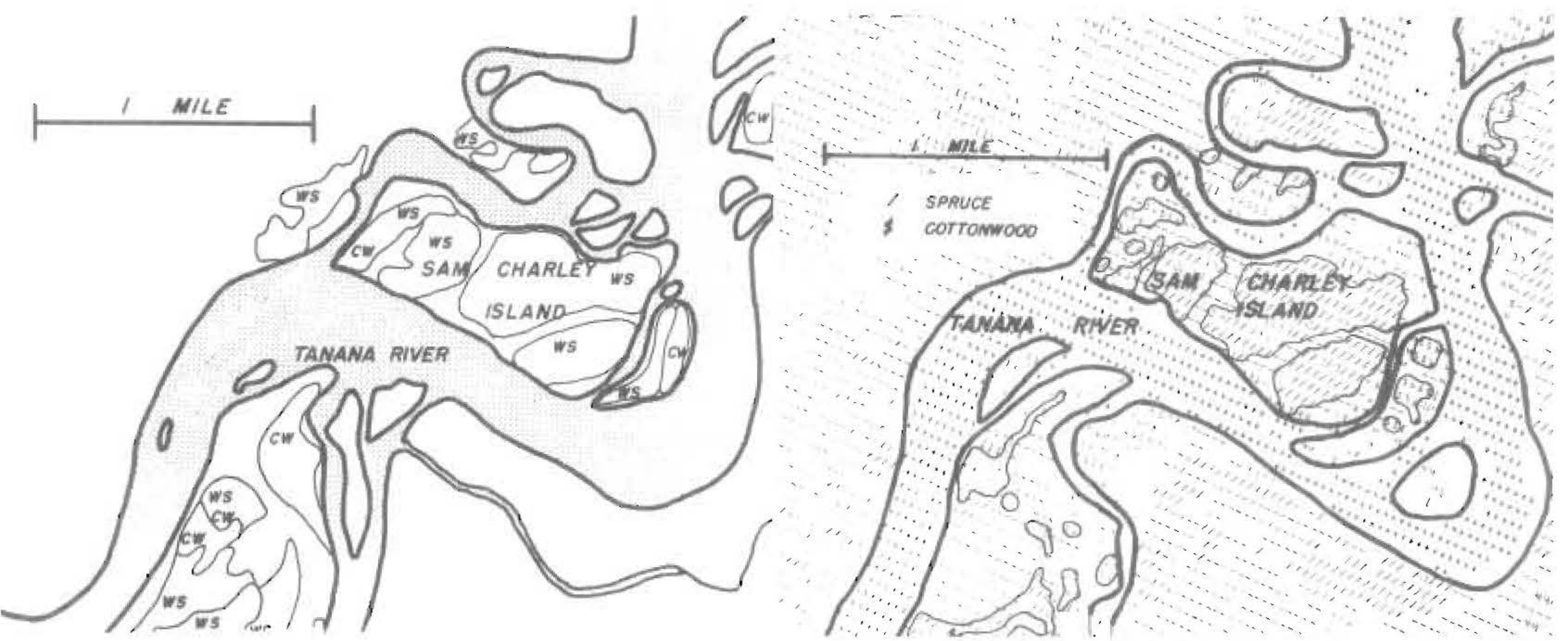


FIGURE 1. A comparison of computer classified vegetation mapping (right) with conventional timber-type mapping (left). The area is a portion of the Bonanza Creek Experimental Forest, Southwest of Fairbanks. The ERTS data map (ERTS-1, scene 1033-21011, 25 August 1972) was originally plotted (1974) at the 1:18,800 scale. Printer-plot symbols (each picel is represented by a printed letter or symbol) and their corresponding vegetation types are as follows: / = white spruce; $ = cottonwood; * = birch and/or aspen; -- = mixed forest including scrubby spruce mixed with birch and shrubs; 1 = tall shrub, primarily willow; 0 = clear water and sometimes dense white spruce; M = muskeg, treeless bogs and low shrub; + = silty water; blanks are unclassified picels. The conventionally prepared map (left) was drawn (1967) from 1:15,840 scale air photos (1962) by Mr. Enzo E. Becia of the Forestry Section, State Division of Lands. The "CW" and "WS" symbols represent cottonwood and white spruce timber types, respectively, on the Division of Lands' map.

(Fig 1). The Division's map was prepared by an expert photo-interpreter (Enzo E. Becia) who used 1:15,840 scale air photos and on-site observations to prepare his map.

Application of Satellite Technology

To further appreciate the capabilities of ERTS technology and how it applies to Alaska, one must realize that the satellite equipment senses data for vast regions at an extremely rapid rate. For example, a single ERTS-1 frame of imagery (Fig. 2) contains data for about 13,225 sq mi, or an area equivalent to about 25,000 times the size of Sam Charley Island in the Tanana River (Fig. 1). Data for an entire ERTS scene (13,255 sq mi) are collected during approximately 28 seconds. The satellite acquires data for a 115-mile wide strip across Alaska in about 3 minutes. Furthermore, the satellite's orbit is such that once every 18 days it passes over the same location on the ground, thus giving temporal (time-lapse) coverage.

Fortunately, computer-compatible tapes (CCT) are available in addition to the imagery forms of data. For vegetation mapping, both data forms are useful; however, the greater amount of information is in the CCT which contain 30,326,400 measurements per multispectral scanner (MSS) scene.

Various vegetation types reflect differing intensities of radiation at given wave lengths (colors to the human eye or bands to the MSS); thus, a "fingerprint" or "signature" for individual vegetation types can be derived by compiling the reflected intensity levels for several wave lengths or MSS bands. With such information, computers can then be programmed to read the CCT data and recognize and classify particular vegetation types.

In the IAS program, we used a Bausch and Lomb Zoom Transfer Scope[1] to optically superimpose air photos (ground truth) information onto computer printouts of CCT data. Such printouts are actually the radiation intensities measured in each band sensed by the satellite's sensors. The radiation intensities ("signatures") are then identified for known vegetation types and other features (Table 1). Signatures from those small test sets (ground truth areas) are then used as training criteria for computer analysis of data for other areas in the ERTS scene.

1. This instrument was purchased jointly by the Institute of Agricultural Sciences and the Joint Federal-State Land Use Planning Commission for Alaska.

Simply stated, we tell the computer how small areas (25-50 acres) of grassland, cottonwood, commercial spruce, muskeg, lakes, silty water, and other features appear in the ERTS-1 CCT data. And then we ask the computer to examine each bit (picel) of CCT data and find all those picels which represent grassland, commercial spruce, etc. Once the computer has "found" the picels of interest, the information can then be portrayed on symbol-coded maps, as color-coded images on a TV screen or printed as color-coded maps with a color digital printer. The latter maps are probably the most useful because they can be easily duplicated for distribution to people who need such information.

Relatively Low Cost

The University's IBM 360/40 computer can classify the ERTS-1 data for a 457 sq mi area (Fig. 3) in about 30 to 60 minutes, or at a rate of 5,000 to 10,000 acres per minute. With computer costs at $100 per hour, that amounts to an automated processing cost of .017 cents to .027 cents per acre, or between 10.8 cents and 17.3 cents per sq. mi. Other direct costs such as computer programming, map drafting, ground truth acquisition, etc., must be added to the above charges. Total cost estimates

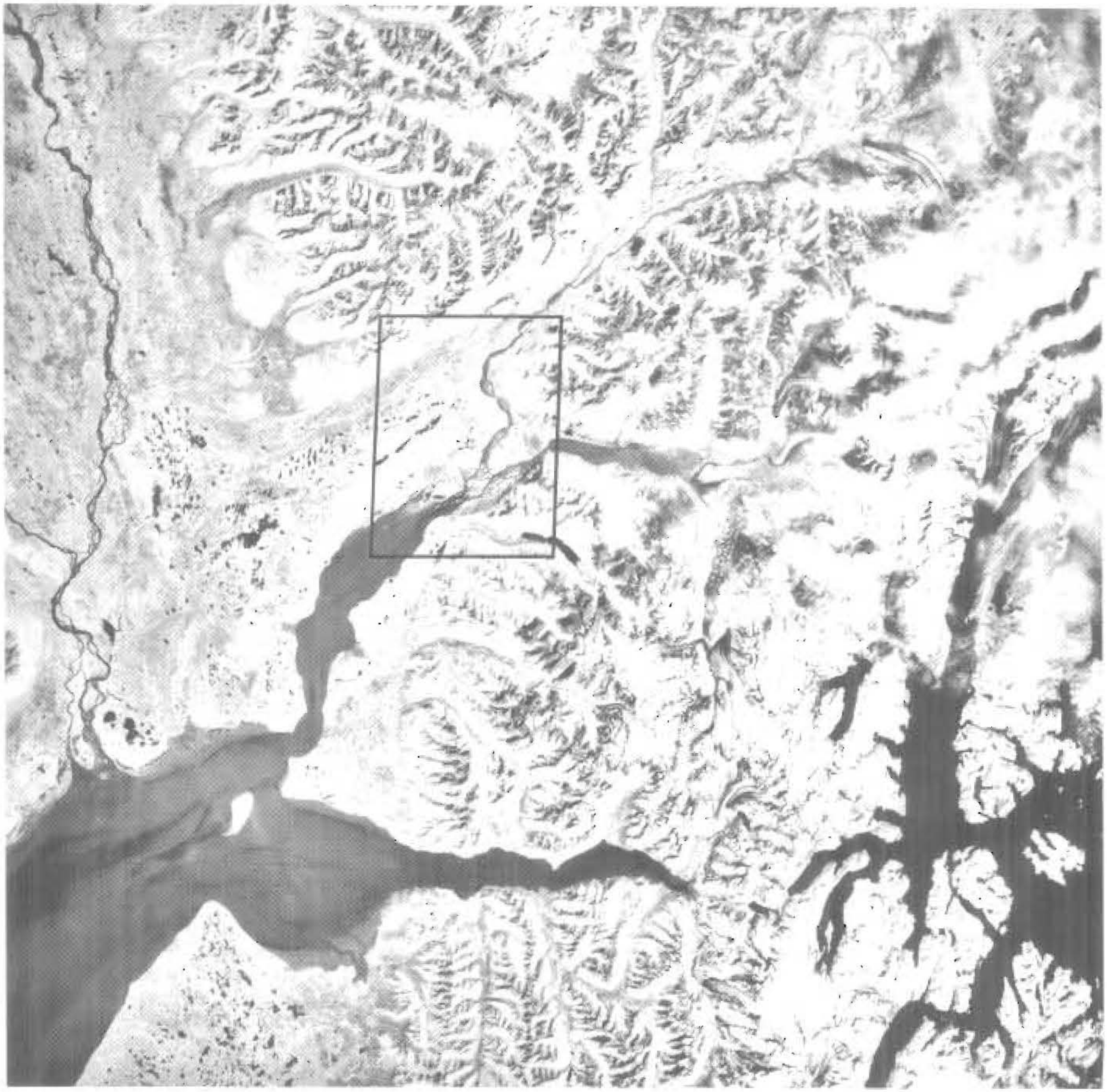


FIGURE 2. Satellite image of area in southcentral Alaska showing upper Cook Inlet (lower left), Susitna Valley (upper left), Prince William Sound (lower right), Talkeetna Mountains (top), Chugach Mountains (center), and Kenai Mountains (bottom). West end of Matanuska Valley enclosed by black lines shows area included in the map and false-color print on facing page. (This image is from Band 7 of the Earth Resourses Technology Satellite-1 [ERTS-1] MSS scene 1390-20450 [17 August 1973]).

FIGURE 3. (On facing page) An example of color digital printing of ERTS CCT data. There are 457 sq mi (1/29th of an ERTS scene) included in this area of the Matanuska Valley. Boundaries of the color print correspond with those of the map projection on the facing page and the locality outlined by black lines in the image above. Geometrically, the ERTS image is "compressed" vertically; therefore, its shape does not match the map's. Since this print was prepared, we have acquired a computer program which corrects the vertical and horizontal aspect ratios, thus removing such geometric distortions. Colors and shades in the ERTS print correspond closely with colors and shades usually observed in color infrared air photos of the Matanuska Valley. Cyan = bare ground and rocks, silty water and urban development; black = clear water and deep shadows; various shades of red = green deciduous vegetation; pink = alpine shrub and certain agricultural fields; blue-green = spruce; and yellow = sparse vegetation. Notice the blue-green areas along the highway and railroad south of Matanuska. On August 17, 1973, when the satellite acquired this imagery, those areas were temporarily inundated by water overflowing from the Matanuska River. The digital color printing was provided by the Dicomed Corporation of Minneapolis, Minnesota.

Goat Peak
MATANUSKA
Lazy Mtn
Matanuska
KNIK

for mapping general vegetation types from ERTS-1 data including those additional charges could amount to less than $2.25 per sq mi (5) depending upon the terrain and location of the units being mapped. Considering the $1000+ per sq mi cost for conventionally acquired resource inventories and the remarkable capabilities of ERTS-1, the cost benefits for regional surveys certainly favor the satellite sensing system.

TABLE 1. Signatures (intensity ranges[a]) for six features in ERTS-1 scene 1390-20450 (17 August 1973) derived from the digital data in NASA's computer-compatible tapes.

	MULTISPECTRAL SCANNER BANDS			
FEATURES	4 .5-.6[b]	5 .6-.7	6 .7-.8	7 .8-1.1
Clear water (Wasilla L.)	17-19	9-10	8-10	1-3
Silty water (Knik R.)	25-29	19-23	16-17	5-7
Scrubby spruce	18-19	11-12	17-18	8-9
Birch	19-22	11-14	31-37	16-20
Alder	21-25	15-19	41-63	31-36
Aspen	19-24	13-16	36-41	21-25

a In order to identify individual features with automated data processing, the feature's intensity ranges must be unique from those of other features in at least one MSS band.

b Wave-length (micrometers) ranges for bands. Visible portions of the electromagnetic spectrum range from about .4 to .7 micrometers.

Broad Applications

Since agriculture includes more than tilled cropland, other possible uses of vegetation maps drawn from ERTS data were explored. Management of grazing lands, national forests, wildlife habitats and recreation areas is associated with natural vegetation types. There is a pressing need for detailed vegetation maps by agencies such as the Bureau of Land Management. Basically, people of that and other agencies need to know the location and extent of their land resources, if they are to manage those resources. Since access to millions of acres in Alaska is limited, managers and planners must often rely on documented information rather than first-hand observations for resource data. Currently such documentation is either nonexistent or in the form of 1:2,500,000 (1 inch = 40 mi) scale maps.

Fire Control

One important facet of wildland management in Alaska is that of fire control. Suppression costs for large fires in Alaska commonly amount to $100,000 per day (3). The fuel conditions (vegetation types) at the fire site must be evaluated in order to act effectively. It is common in Alaska to have several wildfires burning simultaneously. With limited suppression resources, agency people must allocate their efforts wisely. With accurate information on which to base their decisions, they could choose to delay suppression efforts of fires in certain low priority vegetation areas, while giving their full attention to fires in high priority areas. They could also more accurately predict fire behavior from such information, a necessary step in fire control.

Future Capabilities

NASA's operational plans for ERTS include increasing sensor capabilities. Also planned is more complete and frequent coverage of the earth through not only "stationary" satellites, whose orbital period equals the earth's rotation rate, but also several platforms orbiting simultaneously. We anticipate that eventually receiving ground stations, including the Alaska station, will be upgraded to provide real-time data on a regional basis as opposed to the present arrangement with this experimental satellite. At present, all United States data is processed at Goddard Space Flight Center in Maryland and then mailed to the various users.

Other technology advances in data-processing equipment are and will continue occurring. Several private companies have recently developed equipment to process ERTS-1 CCT data. Undoubtedly, such equipment will be integrated into many remote-sensing service facilities in the near future, and the operation of such equipment will be simplified so that the users will be able to process data rapidly and accurately within hours or even minutes from the time the satellite collects the information.

Figure 3 shows an example of what one recently developed piece of equipment is capable of producing. The print was prepared from the "raw" data in bands 4, 5 and 7 by the Dicomed Corporation of Minneapolis, Minnesota. Colors in the digital, false-color print correspond closely to those appearing on color infrared air photos of the same locality. The various shades of red correspond to differing types of green deciduous vegetation; pink corresponds to grasslands and alpine tundra; blue-green represents coniferous forest and muskeg; sky-blue shades correspond with silty water, gravel, bare rock, bare soil, pavement, etc. Clear lakes appear black, and sparse vegetation shows as light yellow. This digital printer can also print color-coded copies of computer-classified data, thus greatly reducing the hand-drawing requirements for producing color-coded vegetation maps.

With such remarkable capabilities developing in the area of satellite sensing, ERTS is indeed providing us with a super bird's-eye view of Alaska. And Alaskans will find it worthwhile keeping an eye on ERTS. □

Acknowledgments

Satellite data and financial support for this work was provided through a University of Alaska contract with the National Aeronautics and Space Administration (NAS5-21833).

Data processing was partially supported by Regional Research Project NE-69 (Atmospheric Influences on Ecosystems and Satellite Sensing).

References

1. Branton, C. I. and Wm. W. Mitchell. 1972. Will remote sensing give us the answer? Agroborealis. 4(1): 19.
2. Belon, E. and J. M. Miller. 1973. Remote sensing by satellite: Applications to the Alaskan environment and resources. Ann. Rep. 1972-73 Geophysical Inst. Univ. Alaska. 12 p. Illustrated.
3. Comiskey, A. L. 1973, private communication.
4. General Information and Economic Factors Concerning the Matanuska-Susitna Borough. 1973. Matanuska-Susitna Borough, Palmer, Alaska. 26 p.
5. McKendrick, J. D. 1973. Mapping Alaskan vegetation from ERTS-1 data. A report to the Alaska Rural Development Council. December 6, 1973, Anchorage, Alaska. (Unpublished manuscript). 8 p.

An Early Sweet Corn For Alaska

DONALD H. DINKEL
Associate Professor, Plant Physiology
ARVO KALLIO*
Professor of Horticulture
University of Minnesota

*Formerly Research Horticulturist, Alaska Agricultural Experiment Station.

Yukon Chief sweet corn, developed at Fairbanks, Alaska, is early enough to produce ears every year when grown through polyethylene. In Alaska's warmest summer areas it also offers potential for growth without polyethylene.

A short-season sweet corn variety, bred and developed in Alaska, is available for Alaskan growers this spring. 'Yukon Chief' is the name of this open-pollinated variety which resulted from a selection from a cross (2472 x Gaspe Flint) made in 1958 at the University Research Farm near Fairbanks, Alaska by Dr. Arvo Kallio. Yukon Chief has the ability to germinate early and establish good stands in the cold soils of northern regions. These characteristics allow the plants to take advantage of the long, warm June and July days occurring in northern latitudes.

Plants of Yukon Chief vary from four to five feet in height and have foliage of medium green color. Ear placement is low on the stalks in comparison to most hybrid sweet corn. Because the variety is open-pollinated the ear size is variable, ranging from six to eight inches long, and averaging one and one-half inches in diameter. The ears are slightly tapered and moderately well filled to the tip with 12 rows of kernels.

Yukon Chief has been grown in comparison with the variety 'Polar Vee' at Fairbanks, Alaska; Duluth, Minnesota; and St. Paul, Minnesota. At St. Paul, Yukon Chief has about the same earliness as Polar Vee. It was three days earlier at Duluth, and about 10 to 14 days earlier at College when both were grown without the use of clear polyethylene soil coverings. When these varieties are grown through clear polyethylene, Yukon Chief will reach maturity at College about one week ahead of Polar Vee. It is therefore slightly better adapted to northern environments, has about the same utility, and is considered to have slightly better quality and appearance.

Some lodging and smut have been observed at St. Paul, but not at Duluth or Fairbanks. Yukon Chief has very good resistance to diseases that can reduce germination and stand in cold soils. No disease or insect problems have been observed on Yukon Chief in Alaska.

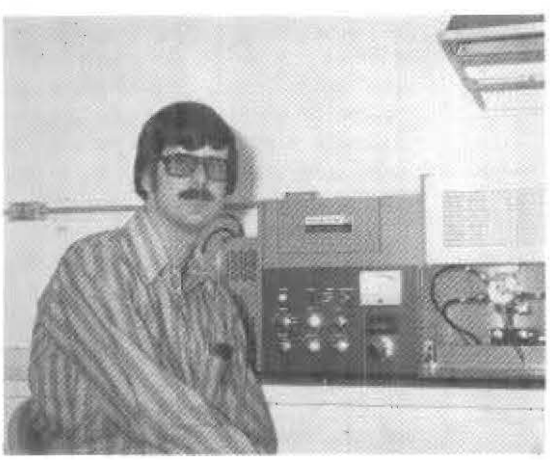
This variety will produce usable ears in most years when grown in the Fairbanks area without polyethylene coverings. However, best and earliest yields are obtained when grown through clear polyethylene. In this growing system the soils are prepared, fertilizer applied and the crop seeded in rows approximately five feet apart. Seeds are sown two per hill, spaced one foot apart in the row. Clear polyethylene of one and one-half mil thickness and four foot width is placed over the seeded row. After the seedling corn plants emerge and attain a height of approximately 6 inches, a slit is made in the plastic just over the plants and the leaves are pulled through the plastic which is left in place throughout the growing season. The sweet corn is allowed to grow in this manner the remainder of the season. Yields of approximately two and one-half ears per linear foot of row have been produced under this system.

Taste-panel tests were conducted at the University of Minnesota on cut-frozen and on-the-cob frozen Yukon Chief along with nine other popular sweet corn varieties. The general rating, color, flavor, shape and texture of Yukon Chief were all judged to be similar to most of the other varieties tested.

Yukon Chief will find acceptance in the far north for local market and home garden use. It also shows promise as a breeding line for development of improved early varieties. □

Two researchers join IAS staff to develop Controlled Environment Agriculture in Alaska

Hertha S. Guthrie



Delbert D. Hemphill, Jr.

Dr. Hertha S. Guthrie and Dr. Delbert D. Hemphill, Jr., have joined the IAS staff as Assistant Professor of Horticulture and Assistant Professor of Biochemistry, respectively. They are stationed at Wildwood near Kenai and will be the Institute's resident scientists for a Controlled Environment Agriculture (CEA) research and development project, working with Dr. D. H. Dinkel of the Fairbanks Research Center. The Kenai Natives, General Electric Company, and the University of Alaska are cooperating on the CEA project that is designed to study year-round salad vegetable production.

Dr. Guthrie is mainly responsible for horticultural research on the project. She was born in Frankfurt, Germany and came to the United States in 1964. She received the German equivalent to a B.S. in agriculture from Friedrich Aeroboe Shule (graduating summa cum laude), and the equivalent of an M.S. in agriculture from Justus v. Liebig University (graduating magna cum laude). She also did doctoral work in animal breeding before coming to the United States and entering graduate work in horticulture. Dr. Guthrie came to Alaska from Pennsylvania State University where she received her Ph.D. in horticulture with a major in plant nutrition. Hertha is a member of Gamma Sigma Delta (the honor society of agriculture), Sigma Delta Epsilon (the honor society for women in science) and the American Society of Horticultural Science.

Dr. Guthrie is married to Sidney C. Guthrie and is an enthusiastic and experienced hobby orchid grower.

Dr. Hemphill's assignment is concerned mainly with plant tissue analyses to detect nutrient imbalance and analyses of the vegetables for potential human nutrition. He received his B.S. in chemistry (with honors) from the University of Notre Dame in 1966, and his Ph.D. in biochemistry from Michigan State University in 1971. Del comes to Alaska from Ithaca, New York where he was a research associate in ornamental horticulture at Cornell University. He is a member of Sigma Xi and Pi Alpha Xi honor societies and the American Society of Plant Physiology, American Society of Horticultural Science and American Chemical Society.

Dr. Hemphill was born in Panama City, Florida in 1944 and was accompanied to Alaska by his wife Rosa (Andy) who is also a biochemist.

Agronomists On The Banks Of The Sagavanirktok

WM. W. MITCHELL
J.D. McKENDRICK
F.J. WOODING
M.A. BARZEE *
Professor and Assistant Professors,
Agronomy

Agronomists supply their own "horse power" to drill in seed for a fertilizer trial in arctic Alaska.

Arctic Alaska has long fascinated explorers, naturalists, and researchers. But until the discovery of the Prudhoe Bay oil field, no serious effort had been made to seed and grow plants in the American Arctic. This was probably due, in part, to a forbidding set of circumstances.

The true Arctic lies north of the limits of tree growth (north of the Brooks Range divide in Alaska). Its climate permits only short tundra growth and causes the development of permanently frozen ground. In some areas permafrost extends over a thousand feet deep. The frozen ground often is interlaced with deep, solid ice wedges. With the advent of oil activities, the need for revegetating disturbed sites under such conditions presented a real challenge.

Agronomists from the Institute of Agricultural Sciences are meeting that challenge with comprehensive and exciting research programs. The Institute became involved in 1969 with a small planting at an oil company drill site (2,4). In 1971 a project was initiated on the Gas Arctic System test pipe near Prudhoe Bay, enabling work to be conducted on a berm over a 4-ft diameter pipe. In 1972, a three-year research program was initiated, supported by a group of oil and gas companies. With this additional support, long-term testing of a large number of materials, techniques, and processes was made possible.

*Deceased

Thousands of Miles Yearly

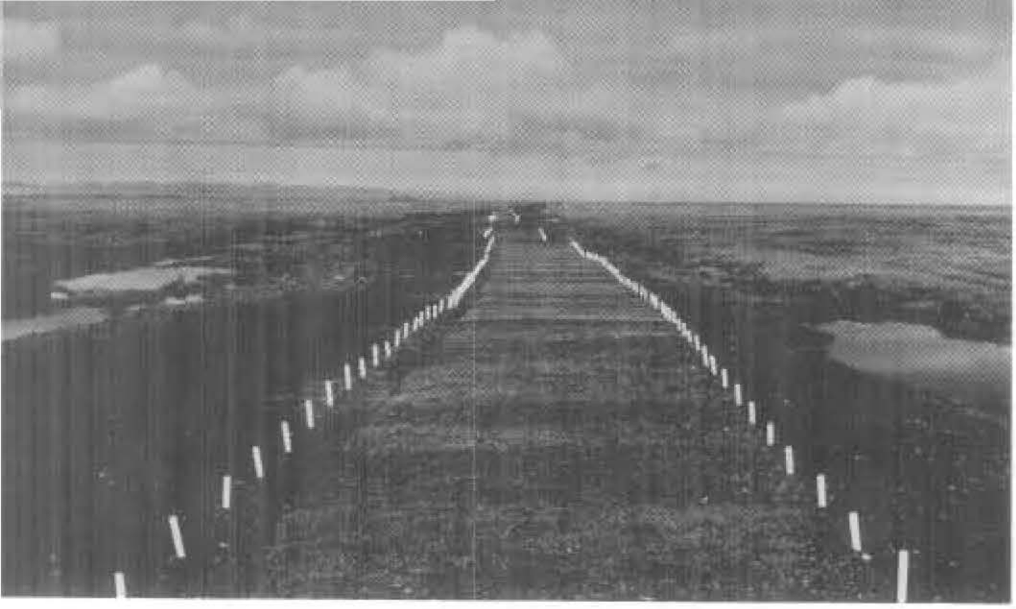
Arctic research projects present logistic problems not encountered by most agronomists. Unlike their counterparts at other state experimental stations, who drive to their field plots, Alaskan agronomists routinely travel thousands of miles by jetliners each year between their Palmer and Fairbanks research centers and the Prudhoe Bay field stations. Working in Palmer and traveling to the Prudhoe Bay oil field is comparable to working in Washington, D.C. and traveling to Milwaukee, Wisconsin.

A typical field expedition begins with several days of planning, inventorying, and packing in order to send supplies and equipment by air freight before the field crew leaves. Finally, the agronomy secretary secures reservations and airline tickets, thus signalling the deadline for all pretravel activities. Usually the crew is divided into two groups. The advance group verifies the safe arrival of all previously shipped supplies and telephones the second group for any needed items that were overlooked.

The day of travel from Palmer begins at about 5 a.m. with a 50-mile drive to Anchorage International Airport to

Life history studies of the native vegetation supply information on adaptive traits.

Good growth was achieved on test pipe berm by experimental and turf grass types developed at the Institute of Agricultural Sciences.



Hundreds of plots have been established to conduct various plant variety, seeding, and management trials.

catch the 7 a.m. "red-eye special." The Wein Air Alaska route includes stops in Fairbanks and Barrow before arriving at the Deadhorse airstrip about noon. The Boeing 737 usually carries a large number of oil field workers, some residents of Barrow, and a few tourists who want to view the Arctic first hand. The cargo compartment contains one or two freight "igloos," large, containerized packages curved to fit inside the fuselage. The final destination is the gravel airstrip near the Sagavanirktok (Sag' a van irk" tok) river at Deadhorse, Alaska.

Here, all efforts become concentrated on using the available time and resources to complete research tasks. Continuous daylight in summer encourages an extension of normal working hours to accomplish more. The research crew travels to the experimental areas in rented pickup trucks on gravel roads constructed across the tundra by the oil companies. These roads generally consist of gravel five to six feet deep, sufficient to prevent excessive thawing of the frozen ground underneath.

Programs and Goals

Some of the field research programs include screening grasses for those adapted to the Arctic, testing fertilizer needs of the soil, monitoring natural perturbations in native plant communities, collecting native grasses for future tests, and evaluating experimental plots. Research is directed at (a) satisfying immediate needs for stabilizing disturbances and (b) providing long term solutions that will become self-sustaining. Because of a lack of any previous information, a wide spectrum of plant materials must be tested for possible use in the Arctic.

Several years of observation are needed to verify which are best suited for the region. Many plants that have appeared promising in their seedling year have subsequently failed. These include a number of commercial varieties that have performed satisfactorily in the forested regions of Alaska. However, other commercially available strains of perennial grasses have successfully established and endured over a three-year period. Furthermore, a number of annuals have developed good stands. As would be expected, the most successful perennials have been grasses of northern origin, principally experimental materials and varieties developed by university and federal government researchers at the Institute. The information thus gained is already being applied in current efforts at rehabilitation.

Investigations must continue, however, to determine the durability of these grasses in the short growing season north of the Brooks Range. Growth commences in the Prudhoe Bay region in early to mid June. It generally ceases by the end of August. Maximum summer temperatures occur most frequently between 40° and 50°F., but often are lower. Freezing temperatures may occur at any time during the brief growing period. However, continuous daylight through the mid-summer period serves to modify some of the low temperature effects.

Long term objectives of the study include finding materials that will maintain themselves once they have been established. Plants native to Alaska that healed nature's scars before man ever arrived on the scene are being studied. Considerable native material was available for testing because of research initiated in 1956 with Rockefeller Foundation support (1,7). That support continued until 1966. Collections are made every year in various regions of Alaska by staff members of the Institute. During a recent ecological survey along the proposed Trans-Alaska pipeline route many plants were obtained for evaluation at the Institute (3). Revegetation work in other areas has indicated the possible range of adaptability of various materials (5,6).

These efforts are now producing results in the trials underway in the Prudhoe Bay oil field. However, there are no commercial seed supplies of most of these materials. Thus, seed of successful selections must be increased for release to growers to produce commercial quantities for revegetation projects.

Caribou and Geese Grazing

Other experiments in progress at Prudhoe also have provided information of considerable value. Definitive data on

Agronomists lay first "tundra railroad" on North Slope to transport a rototiller across hummocky terrain.

fertilizer treatments have been among the early rewards of the program. However, there has been considerable competition in reaping the benefits of these experiments. Grazing by caribou and geese is a problem normally not encountered by agronomists elsewhere. During late summer and early autumn the revegetation plots are particularly palatable to geese and caribou, probably because the native vegetation senesces more rapidly than that in the plots. In 1972 the caribou ruined 2/3 of the fertilizer trials during the night before yield measurements were taken. In 1973, trials were conducted in fenced plots, but caribou eventually jumped the fences and grazed in the plots. Fortunately the 1973 data were collected before the plots were grazed.

Other information applicable to the tundra vegetation project was obtained from a two-year Tundra Biome study at Prudhoe Bay which involved transplanting clones of grasses from several locations in Alaska and Colorado into an experimental garden. A brief, but quite interesting Tundra Biome project was also conducted at Barrow in 1973 wherein the effects of fertilizers on carbohydrate and nitrogen reserves in native grasses were tested.

These projects, which may seem to some as being rather removed from agriculture, are actually closely tied to fertilizer use, and grass seed and forage production.

Acknowledgments

Financial support for the revegetation research discussed herein has been provided to the University of Alaska by the Alyeska Pipeline Service Co., Atlantic Richfield Co., Battelle Memorial Institute (prime contractor for Gas Arctic Systems), Canadian Arctic Gas Study Limited, Exxon Company, Shell Oil Co., and Union Oil Company. The Tundra Biome study receives funds from the National Science Foundation and various oil company and state sources. □

REFERENCES

1. Klebesadel, L.J. 1973. Grasses and legumes for revegetation in Alaska. 1973 Alaska Revegetation Workshop Notes. Univ. of Alaska Coop. Extension Service Publ. RP-239. p. 16-23.
2. Mitchell, W. W. 1970. Revegetation problems and progress. Agroborealis.2:18-19, 22.
3. ————. 1970a. A scientific tour of pipeline route. Agroborealis.2:4-5, 22.
4. ————. 1973. Adaptations of species and varieties of grasses for potential use in Alaska. Proceedings of a Symposium. Impact of Oil Resource Development on Northern Plant Communities. Univ. of Alaska Inst. Arctic Biology Occasional Publication on Northern Life 1. 2-6.
5. ————. 1973a. Using native plant resources for conservation. Agroborealis. 5:24-25.
6. ————. 1973b. Alaskan climatic and ecological patterns as related to revegetation possibilities. 1973 Alaska Revegetation Workshop Notes. Univ. of Alaska Coop. Extension Service Publ. RP-239. p. 51-58.
7. Taylor, R.L. 1970. Red fescue—A valuable species. Agroborealis.2:8, 10.

IN MEMORIAM

Milton A. Barzee (1942-1973)

On December 24, 1973, just one brief but eventful year after joining the Institute staff, Milton Barzee died of an apparent heart attack.

Milton was engaged in plant physiology and environmental research activities of considerable significance to Alaska. Various petroleum companies operating in Alaska were funding his research projects which dealt specifically with revegetation problems being encountered by those companies. Furthermore, his training in the herbicide field qualified him to fulfill a critical need for weed control research and associated subjects. Milton also had a deep interest in various facets of seed production, a budding agricultural industry in Alaska.

Milton first arrived in Alaska on an interview trip August 23, 1972. On August 25, 1972 he was whisked to the North Slope where extensive research in revegetation is underway. An early taste of winter conditions in the Arctic did not deter him from seeking the University of Alaska position. He obviously welcomed the research challenges he found in Alaska.

After moving to Palmer in January 1973, Milton became very much involved in revegetation research. He initiated a comprehensive research project on seed germination both on the North Slope and at Palmer. Seeds were treated with hormones and other test solutions and then planted in field plots at Prudhoe Bay. He also initiated trials studying temperature effects on germination. Before moving to Alaska, Milton supervised the construction of the Institute of Agricultural Sciences' thermogradient plate, a complex piece of equipment for establishing and controlling a temperature gradient across a metal surface. With this equipment he tested the germination of about 20,000 seeds along a temperature range from near freezing to 80° F.

Milton was involved in research being conducted both at Palmer and Prudhoe Bay on rehabilitation of oil spill damage. Much of this was concerned with the effects of burning as a means of cleaning up oil spills.

Possible environmental effects of various materials proposed as hydrostatic test fluids for the trans-Alaska pipeline also came under Milton's purview. His findings have led to the continuance of this important work.

Just prior to his death he completed an extensive review of research on the effects of certain air pollutants on northern latitude plants. This review probably constitutes the most exhaustive compilation of past and current research of this nature in existence.

Milton's graduate training, both for the master's degree and the doctorate, was as a crop physiologist with emphasis in weed control work. He obtained his bachelor's degree at Utah State University and his master's at Ohio State University. He had just completed his final requirements for the Ph.D. degree from Oregon State University in November. Milton was the only person in Alaska filling a professional position in the very important field of weed control work. He had initiated research on the use of herbicides and their residual effects. He was particularly interested in a new, experimental herbicide that appears to have considerable potential for cropland and roadside application. His death has created a critical need in Alaska for a professional person in this discipline.

Milton has been deeply missed both personally and professionally. He was esteemed by all of his associates for his integrity and his earnest, friendly manner.

PUBLICATIONS

Branton, C. I. and R. H. Shaw. 1973. Growing-degree units for selected agricultural locations in Alaska. University of Alaska Institute of Agricultural Sciences Technical Bulletin No. 4.

Flynn, E. J. and W. C. Thomas. 1973. Assessment of the market for fresh vegetables in Anchorage. G. E. – TEMPO Research Publication, 73TMP-23.

Keller, W., and L. J. Klebesadel. 1973. Forages in the Intermountain States and Alaska. (Chapter in) M. E. Heath, D. S. Metcalfe, and R. F. Barnes (eds.) Forages: The Science of Grassland Agriculture. Iowa State University Press. p. 486-498.

Klebesadel, L. J. 1974. Grasses and legumes for revegetation in Alaska. (In) 1973 Alaska Revegetation Workshop Notes. Alaska Cooperative Extension Service Publication RP-239. p. 16-23.

Laughlin, W. M., P. F. Martin, and G. R. Smith. 1973. Processed crab waste: liming and fertilizer value on two Alaskan soils. University of Alaska Institute of Agricultural Sciences Research Report 73-1.

Marsh, C. F. 1973. Consumer attitudes toward milk consumption, Fairbanks, Alaska. University of Alaska Institute of Agricultural Sciences Research Report 73-2.

Marsh, C. F. 1973. Quarterly report on Alaska's food prices. University of Alaska Institute of Agricultural Sciences and Alaska Cooperative Extension Service.

Marsh, C. F., A. L. Brundage, and L. E. Cavasos. 1973. Veal production and marketing in Fairbanks, Alaska. University of Alaska Institute of Agricultural Sciences Research Report 73-3.

Marten, G. C., R. F. Barnes, A. B. Simons, and F. J. Wooding. 1973. Alkaloids and palatability of Phalaris arundinacea L. grown in diverse environments. Agronomy Journal. 65:199-201.

Mitchell, W. W. 1973. Adaptation of species and varieties of grasses for potential use in Alaska. Proceedings of a Symposium on the Impact of Oil Resource Development on Northern Plant Communities. University of Alaska Institute of Arctic Biology Occasional Publication on Northern Life 1. p. 2-6.

Mitchell, W. W. 1973. Alaskan climatic and ecological patterns as related to revegetation possibilities. 1973 Alaska Revegetation Workshop Notes. University of Alaska Cooperative Extension Service Publication RP-239 p. 51-58.

Thomas, W. C., L. Blakeslee, L. Rogers and N. Whittlesey. 1973. Separable programming for considering risk in farm planning: Reply. American Journal of Agricultural Economics. 55:117-118.

Thomas, W. C., C. F. Marsh, and C. A. Stephens. 1973. An economic analysis of red meat, fish, poultry and wild game consumption patterns in Anchorage, Alaska. University of Alaska Institute of Agricultural Sciences Research Report 73-4.

University of Alaska Institute of Agricultural Sciences Staff. 1973. A review of some research in progress. Agroborealis Vol. 5, No. 1.

White, G. K. and W. C. Thomas. 1973. A method for establishing outdoor recreation project priorities in Alaska. University of Alaska Institute of Agricultural Sciences Research Bulletin 40.

Wilton, A. C., and L. J. Klebesadel. 1973. Karyology and phylogenetic relationships of Phleum pratense, P. commutatum, and P. bertolonii. Crop Science. 13:663-665.