Agroborealis

Volume 11, Number 1, January/1979

Agricultural Experiment Station
University of Alaska

FROM THE DIRECTOR'S DESK

Alaska's agriculture is changing, and with change come challenges and opportunities for agricultural research. Actions by Alaska's State Government, State Legislature, and individual Alaskan farmers and ranchers have established new directions for agricultural development within the state. Some key events which occured during 1978 influenced these directions:

- The Governor of Alaska and the Alaska State Legislature created the Alaska Renewable Resources Corporation to assist in the development of renewable resources, including agriculture.
- The Commercial Fishing and Agriculture Bank was established by the Alaska State Legislature to provide financing for Alaska's agricultural and fishing businesses.
- The state of Alaska sold 60,000 acres of land in interior Alaska near Delta Junction in tracts of 2,000 to 3,600 acres for agricultural purposes. Contracts have been awarded to clear the land for cropping with an initial goal of commercial production of small grains and oilseed crops on the new land by 1980.
- Agricultural rights to an additional 5,000 acres of state land near Delta Junction were sold in tracts of 20 to 325 acres for diversified farming.
- Early in 1979, construction of an elevator complex for drying and storing grain will begin near the new farms as part of a system to supply barley and rapeseed locally and to markets in Pacific-rim countries.
- To test a marketing system with Japan, contracts have been signed by Alaskan farmers to produce barley and rapeseed on existing farms during the summer of 1979.
- Near Homer on the Kenai Peninsula, 2,600 acres of state land were sold in tracts of 40 to 420 acres—also for agricultural purposes. Production from these tracts will add to that from existing farms and the 71,000 acres of rangeland leased to ranchers for grazing livestock on the Kenai Peninsula.
- Herders belonging to the Northwest Alaska and the Bering Straits Native Associations are expanding their reindeer herds for the commercial production of meat and antlers. The Tanana Chiefs Conference is encouraging vegetable production for local use in rural villages of interior Alaska.
- In the Fairbanks area, systems are being considered for utilizing surplus industrial heat to warm soils and greenhouses for the commercial production of horticultural crops.

Each of these enterprises reflects an increasing awareness of the economic and social benefits of agriculture as a renewable resource. Extensive public participation in the Alaska Public Forum during the past two years showed substantial public interest in the development of renewable resources in Alaska. Results reported in the 1978 Public Forum Newsletter were succinct: "If there was ever a clear mandate from Public Forum participants, it is that the state significantly support the development of Alaska's renewable resources."

This issue of *Agroborealis* describes some current research at the Agricultural Experiment Station that is designed to provide a scientific and technological basis for agricultural development in Alaska. Agricultural research is essential if agricultural development is to produce food as well as provide the economic and social benefits associated with agricultural enterprises in an economically and environmentally sound manner.

James V. Drew, Director

Agroborealis

January/1979

Volume 11 Number 1

Agricultural Experiment Station
School of Agriculture and Land Resources Management
University of Alaska

Agroborealis is published under the leadership of the AES Publications Committee: J. V. Drew, A. L. Brundage, L. J. Klebesadel, J. D. McKendrick and W. C. Thomas.

Managing Editor Mayo Murray

Printed by Northern Printing Co., Inc., Anchorage, Alaska.

Agroborealis is published by the University of Alaska Agricultural Experiment Station, Fairbanks, Alaska 99701. A written request will include you on the mailing list. The Agricultural Experiment Station at the University of Alaska provides station publications and equal educational and employment opportunities to all without regard to race, color, religion, national origin, sex, age, physical handicap, or veteran status.

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ABOUT THE COVER. . .
Lupines frame this scene of native bluejoint rangeland near the Agricultural Experiment Station's Homer Research Center on the Kenai Peninsula, Alaska. Facilities for weighing research cattle during summer-grazing trials are in the center of the picture; field plots for research on intensive forage management are in the background.

Photo by Jay D. McKendrick

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The Homer Research Center, designed to carry out research in beef production, located about 10 miles east of Homer, Alaska.

The Homer Beef Production Project

A Cooperative Effort in Applied Research

Jay D. McKendrick*
Wm. W. Mitchell**
Fredric M. Husby***

Alaska's relatively small but growing population imports over 90% of the red meat consumed in the state. Yet Alaska's tall-grass-forb range resources are vast and underutilized by either wildlife or domestic grazers. This incongruity has led to the belief that expanding Alaska's agricultural beef industry would benefit the state and its consumers by utilizing local renewable resources and by reducing dependence on distant food production. The Homer Beef Production Project is a cooperative effort between ranchers, researchers, and state government which is aimed at increasing and properly utilizing local range resources. Applied research is being directed at specific beef production problems on the lower Kenai Peninsula.

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Range Resources Equate with Beef Prices

Lush summer growth on native rangelands of the Kenai Peninsula and at other locations where the tall-grass-forb plant communities occur has for years attracted stockmen's interests in Alaska. To ranchers, range forage production means low-cost feed, a component essential for economically viable livestock operations. To a nation of consumers, large rangeland resources mean low-cost beef relative to nations without such resources (Table 1). Pioneering Alaskan ranchers readily learned, however, that along with the advantages of the high-producing summer range were the disadvantages of a long winter feeding season. Winter feeding of cattle usually means high-cost feed, a component that reduces ranching profits.

Operators attempting to make a living on any livestock production operation need to know the various management options available to their enterprises. They must also know the quantitative effects of such options in terms of input costs and production gains. Without such data, each rancher must test his system by trial and error, until a profitable combination is found. Such a practice would be time consuming, inefficient, and probably an impossibility for most ranchers. Consequently, in the U.S., State University Agricultural Experiment Stations have been traditionally charged with researching and reporting such information. The results have been largely responsible for the average U.S. consumer having to allocate less than 17% of his disposable income for food, a historically and internationally commendable achievement (1).

Ranchers and Researchers Meet

Ranchers on the lower Kenai met with members of the Agricultural Experiment Station in October of 1976 to formulate plans for a research project. The information needs voiced by ranchers centered on forage and animal feeding problems. A multidisciplinary project including agronomy, range, and animal sciences began in July of 1977 to address some of those questions.

Agronomic studies focused on cropland forage production (the winter feed source); both soil fertility and grass variety trials are integral parts of that research. Management of native hay meadow is under study with the possible benefits of establishing other forages. Also hays from several farms were sampled to identify the most critical quality components affecting utility of those winter feeds. Chemically curing the standing hay crop was attempted to see if that procedure could be used to delay plant senescence, thereby extending the normally brief harvest season. The agronomy and animal science departments at the Palmer Research Center cooperate in providing laboratory facilities to analyze forage quality and soil fertility.

Range research included plant inventories and production measurements of native range during the summer of 1978. Utilization levels for two stocking rates were determined on grazed sites. Effects of grazing pressures on the range plant communities must be known if the resource is to be maintained. Usually several seasons of grazing are needed to acquire such data, however. Sampling included periodic range forage collections to determine seasonal changes in forage quality and animal diet selections.

Quality of standing dead forage available for early spring grazing prior to emergence of new plant growth was of particular interest to some stockmen who often face feed shortages in early spring. The growth and development of native bluejoint (*Calamagrostis canadensis*) plants was examined to better understand the strong and weak points of the species in terms of hay and range utilization and management.

Animal research focused on seasonal responses of weaner calves to varying levels of winter feeding and summer grazing intensitites. The object was to secure animal forage consumption and gain data useful in allocating winter feeding and summer grazing resources. Stockmen should be able to use that information in calculating the least-cost and maximum-profit options for their own operations.

The two-year project terminates in June of 1979 and is a cooperative venture that includes the local ranchers, the University of Alaska, Agricultural Experiment Station and the State of Alaska's Department of Natural Resources, Division of Agriculture. Local stockmen provide weaner calves for the feeding and grazing trials. The Division of Agriculture administers operational funds, and the Agricultural Experiment Station designs and conducts the research.

Table 1: Listing of prices for a selected beef cut among several national capitals

	U.S. \$/kg Boneless Sirloin Steak[a]
Tokyo[b]	35.09
Copenhagen[b]	14.08
Bonn[b]	12.43
Stockholm[b]	12.32
Brussels[b]	11.22
The Hague[b]	10.77
Rome[b]	8.65
London[b]	8.53
Paris[b]	8.11
Ottawa	5.43
Washington	4.81
Canberra	4.58
Pretoria	3.70
Mexico City	2.60
Brasilia	2.02
Buenos Aires	1.17

[a] 3 May 1978 prices according to USDA, Economics, Statistics and Cooperative Service, July 1978 issue of *Agricultural Situation*, 2.02 kg = 1 lb.

[b] Capitals in countries without extensive rangeland resources.

Research Findings Conveyed Directly

Provisions in the project allow for semiannual meetings whereby data and results are given directly to the ranchers. The University of Alaska Cooperative Extension Service coordinates the meetings and notified the participants and others interested in the project. The meetings have allowed local stockmen the opportunity to ask specific questions of the researchers and extension specialists in addition to providing input for project refinement. That approach reduces the usual delay between discovery and reporting of agricultural research findings. That should also reduce delays between discovering and implementing new technology on Alaskan farms and ranches.

This issue of *Agroborealis* contains a report of some findings during the first 15 months of the Homer Beef-Production Project. Other data and reports will be forthcoming as experiments are completed. The potential for Alaska to become more self-sufficient in red-meat production is very real. Realizing that potential greatly depends upon gaining the knowledge of how to utilize profitably range and forage resources. Special efforts such as the Homer Beef-Production Project will help achieve those goals.□

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Hay Quality Survey for the Homer Beef Production Project-1977

Jay D. McKendrick*

To go from one point to the next, a traveler must constantly maintain a sense of position and direction. So it is with research—without knowing where we are, we cannot proceed to our destination in an orderly fashion. An important part of the Homer Beef Production Research Project at the Alaska Agricultural Experiment Station (16) was assessing the need for improving nutritional quality as well as yields of Alaskan hays. The quality of hays produced by Alaskan farmers is largely unknown. Occasionally a farm-produced hay is tested for protein, but other nutrients are almost never measured. Without such information, stockmen cannot know which nutritional components need supplementing in order to provide a balanced ration.

Methods of improving forage and hay production have been researched for several decades in Alaska by federal and state agricultural plant scientists (8, 11, 12, 14, 13, 19). Forage quality research has been one of lesser agronomic effort, relative to production studies. Inadequate laboratory space, equipment, and numbers of technicians for routine testing of forage quality were primarily responsible for that situation.

Traditionally, experimental hay crops in Alaska and elsewhere have not been simultaneously tested for both mineral and organic constituents. Plant scientists, whose efforts were aimed at forage-plant growth, have usually examined major mineral fractions, N, P, K, Ca, and Mg, with respect to fertilizer and crop variety experiments. Animal scientists, concerned with animal growth experiments, have usually examined digestibilities, fiber, lignin, carbohydrate, and protein fractions (2, 3, 4). Costliness of comprehensive analyses for both mineral and organic fractions has dictated the dichotomy of past experiments more than has divergence of interests between the two scientific disciplines. Both research groups recognized the importance of mineral and organic constituents to hay quality, and the current tendency in Alaska is toward a more unified and cooperative multidisciplinary approach.

Quality may differ substantially between hays grown in experimental plots and those of farm fields. Test-plot crops have usually been cured in dryers and those hays may have substantially higher quality than hays on local farms that have been subjected to weather damage during field curing. Furthermore, there are rather wide variations in protein levels among Alaska's native grasses. Irwin (8) cites total crude protein values of 4.58% for Alaskan bluejoint (*Calamagrostis canadensis*) hays. Similar protein levels, 4.6%, were noted for that grass in a more recent Alaskan study (15). Total crude protein levels of 2.5% are common in bluejoint plants after autumn frosts. Such levels are too low to meet animal nutrient requirements. Contrastingly, in a seasonal study of two Alaskan tundra grasses (*Arctagrostis latifolia* and *Dupontia fisheri*) the minimal level of total crude protein in shoots was about 7.5% (17), a level suitable for the diets of several livestock classes. Protein levels in naturally cured grasses may not be the most limiting quality factors in terms of animal dietary needs in other Alaskan hays and forages.

Expert farmers can, within broad limits, judge the quality of hay by its outward appearance, and they can similarly assess the effectiveness of such feeds on animal performance. But when deficiencies occur, it is difficult to identify the specific cause by visual inspection. Protein, minerals, digestibilities, and other nutritional components of hays are not evidenced by outward appearances; those components can be measured only by laboratory analyses.

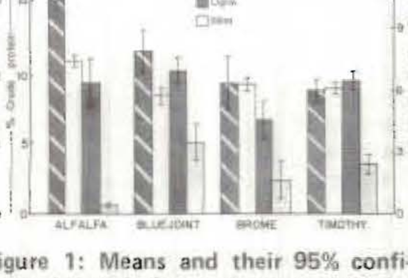

Figure 1: Means and their 95% confidence intervals for crude protein, lignin, silica, and metabolizable energy (M.E.) in four species of Alaskan hay crops. All alfalfa data but one sample came from crops produced outside Alaska and were included in the survey for comparison purposes.

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Therefore, in 1977, several lots of locally grown hays, mostly from the lower Kenai Peninsula, were tested for quality. The purpose of the survey was twofold: 1) to alert Alaskan stockmen to nutrition problems in their own hays, and 2) to give Alaska's agricultural researchers guidance in assigning future research priorities. The survey is still in progress and being expanded beyond the Kenai Peninsula during 1978-79. Protein and digestibility components for the first year of this survey are discussed below. Results of mineral analyses will be presented in a subsequent report.

Table 1. Forages and other feeds tested.

Alfalfa	7
Bromegrass	6
Bluejoint	21
Timothy	26
Hairgrass hay	3
Meadow foxtail hay	3
Oat silage	1
Oat/flax silage	1
Quackgrass	1
Wheat straw	2
Bluejoint (over wint.)	2
Fern	5
Pelleted horsefeed	3
Shelled corn	2
Seaweed	7
Sedge hay	1
Russian thistle	1
Cheatgrass	1
Total Samples	93

METHODS

Sample Collection and Classification

Samples were collected from local ranchers primarily from the lower Kenai Peninsula. Ninety-three samples were gathered (Table 1) of which 64 were Alaskan-grown hays. The other 29 samples included alfalfa, shelled corn, and a few miscellaneous forages produced outside Alaska, so ranchers familiar with animal performances on such feeds, could rate their Alaskan-grown crops. Alfalfa (*Medicago sativa*), bluejoint, timothy (*Phleum pratense*), and bromegrass (*Bromus inermis*) data were statistically compared as individual hay types (Figure 1). The other forages occurred too sparingly to be statistically evaluated as separate classes in this survey.

Laboratory Analyses

Analyses were performed by plant and animal science technicians at the Palmer Research Center's laboratory.

Table 2. Minimum dietary requirements (60°C dry matter basis) calculated for four beef and two sheep weight classes. (21, 22).

Animal Class	Management Objective	Crude Protein (%)	IVDMD (%)	Metabolizable Energy (Mcal/kg)
Steer (400 lb)	maintenance	8.1	60.3	1.91
Steer (440 lb)	1.1 lb./day gain	9.5	60.6	2.01
Heifer (715 lb)	last 1/3 preg.	8.4	54.8	1.82
Cow (990 lb)	mid 1/3 preg.	5.6	54.8	1.82
Ewe sheep	maintenance	8.5	56.9	1.89
Lamb (88 lb)	finishing	10.5	72.4	2.39

Crude protein was calculated from percent nitrogen data (6.25 x % N = crude protein). The feeds were tested for apparent digestibilities by the two-stage *in vitro* dry matter disappearance (IVDMD) technique. Lignin was measured by weight following oxidation with potassium permanganate. Insoluble silica was weighed on ash residues following hydrobromic acid washing. All values were calculated on the 60°C oven-dry basis. Sixty-degree dry matter averages about 97% of 100°C dry matter.

RESULTS AND DISCUSSION

The means and their 95% confidence intervals for several quality components for alfalfa, bluejoint, bromegrass, and timothy, the major species represented, are described and discussed below relative to standard animal requirements (Table 2). In Figure 1, means within quality components whose 95% confidence intervals do not overlap are considered statistically different from each other.

Total Crude Protein

Figure 1 shows the relative crude-protein values for the four main forage species. As expected, the total crude-protein levels for native bluejoint hay were significantly better than those for timothy hays, a domestic grass introduced to Alaska.

Of the animal classes listed in Table 2, these timothy hays averaged below minimum protein requirements for finishing lambs. Nearly 40% of the timothy lots were deficient in protein for both classes of sheep. Hairgrass, oat silage, oat and flax silage, sedge hay, stem-cured cheatgrass, and wheat straw samples were all below dietary requirement levels for all animals considered (Table 3).

Total crude-protein levels in 97% of the Alaskan hays in this survey were adequate for maintaining dry cows

Table 3. Total crude protein, *in vitro* dry matter disappearance (IVDMD), and calculated metabolizable energy (M.E.) values for three Alaskan and two non-Alaskan forage plants which have matured and/or died naturally and other miscellaneous feeds.

Feed	Origin	Cr. Prot. (%)	IVDMD (%)	M.E. (Mcal/kg)
Pelleted horsefeed	Anchorage	18.7	50.0	1.75
Hairgrass hay	Kodiak	6.4	41.0	1.45
Wheat straw	Idaho	5.3	49.0	1.75
Sedge hay	Homer	5.8	51.2	1.80
Shelled corn	Idaho	9.4	89.9	3.12
Meadow foxtail hay	Homer	14.7	61.2	2.14
Oat silage	Homer	8.1	48.7	1.71
Oat-flax silage	Homer	6.9	42.8	1.51
Quackgrass	Palmer	8.5	53.1	1.86
Bluejoint	Homer	5.4	29.2	1.04
Seaweed	Homer	14.9	49.7	1.74
Seaweed	Kodiak	9.6	43.4	1.53
Fern, overwint. green	Homer	14.1	51.9	1.82
Fern, overwint. dead	Homer	10.3	22.7	0.82
Fern, fiddleheads	Homer	29.9	57.8	2.02
Cheatgrass	Idaho	5.8	52.6	1.84
Russian thistle	Idaho	11.7	61.9	2.16

Sheep belonging to Pete Roberts (above), operator of the Twitter Creek Ranch near Homer, Alaska, graze on bluejoint reedgrass ranges during the summer.

The Agricultural Experiment Station's Hereford bull on summer range near Homer, Alaska.

(Table 4). For cow-calf operations, local hays in 1977 were for the most part adequate. For finishing lambs and calves, only 62% and 47% of the hays, respectively, met the crude protein requirements. Since hays are not usually relied upon for finishing animals, limitations in that sense should be of minor consequence to the Alaskan red-meat industry as a whole. Of course, individual ranchers must always ensure that the protein requirements for their specific operations are met.

Since total crude-protein levels in grasses usually decline as the plant matures, properly timing hay cutting should reduce most protein deficiency problems in Alaskan hays (8, 15). Rapid growth of grasses and brief harvest seasons often handicap Alaskan haymaking (10). Weather, unfavorable for hay curing, is also an obstacle to properly timing hay harvesting in southcentral Alaska. Access to accurate short- and long-range weather forecasts and the capability for quickly harvesting hays during favorable weather conditions are vitally important in obtaining good hay in this region. Management techniques that could speed the curing process are needed. Methods of curing grass plants on the stem before portein declines occur would also enlarge harvest-time options.

Digestible Crude Protein

Digestible crude protein is the fraction of total crude protein important to animals. Unfortunately, this survey did not include digestible crude protein. The seasonal changes in digestible crude protein for native bluejoint were calculated from data of a prior study at the Palmer Research Center (Figure 2). Both total and digestible crude-protein levels declined as bluejoint plants aged. On an unfertilized stand soon after plants headed, bluejoint's total crude-protein level was about 8.5%, and nearly 80% of that protein was digestible in the laboratory by the two-stage *in vitro* technique. After the standing bluejoint plant cured and lost its green color, the total crude protein declined to about 2.5%. In the stem-cured state, about 98% of the protein was indigestible. Thus, the standing-dead bluejoint plant has one-third or less the total protein of the live shoot at the heading stage and has practically no digestible protein. These data reinforce the importance of harvesting bluejoint hay at the proper time.

Unpublished data from experiments at Homer and Palmer indicated that chemically curing native bluejoint delayed the normal loss in crude protein as the crop matured. Those particular treatments caused rather sharp declines in metabolizable energy, however. That undesirable effect on metabolizable energy must be overcome before the chemical curing practice can be implemented. The prospects for biochemically manipulating plant aging to control quality losses in forages are plausible and should be investigated.

Metabolizable Energy

Currently, many people are becoming acutely conscious of the importance of energy flow and the efficiency of energy flows in natural and managed ecosystems. The significance of such factors in cold-dominated regions, such

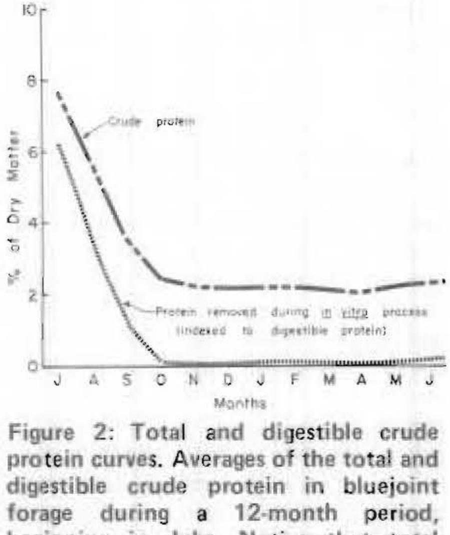

Figure 2: Total and digestible crude protein curves. Averages of the total and digestible crude protein in bluejoint forage during a 12-month period, beginning in July. Notice that total crude protein and digestible crude protein approach 2.5% and 0%, respectively after bluejoint shoots mature and die in September. Those standing dead plants remained poor sources of protein and were low in both metabolizable energy (1.0 Mcal/kg) and minerals; thus, bluejoint-dominated ranges are extremely poor forage sources for early spring grazing prior to new shoot's emergence in June.

Table 4. Per cent of Alaskan hays with adequate crude protein and metabolizable energy (M.E.) for five selected classes of ruminants.

Animal Class	Management Objective	Crude Protein	M.E.
Dry preg. cow	maintenance	97	45
Ewe sheep	maintenance	76	32
Steer (400 lb.)	maintenance	68	16
Steer (440 lb.)	1.1 lb/day gain	53	14
Lamb (88 lb.)	finishing	38	0

as Alaska, are apparent. Winter, when little or no solar energy is being fixed in forage plants by photosynthesis, is relatively long at this latitude. Consequently, grazing animals must depend upon energy sources stored in plants during the brief, but productive, summer season. Without adequate energy, animals cannot grow, reproduce, and lactate according to their genetic potentials.

In this study, over half of the Alaskan-grown hays (55%) were deficient in metabolizable energy (M.E.) for cattle and sheep, according to recognized standards (Table 4). M.E. data were calculated from IVDMD values (4). Alfalfa, the legume, ranked higher in M.E. than in the three grasses (Figure 1). Among the three major grass hays, bluejoint and timothy averaged less in M.E. than bromegrass. Bromegrass was generally adequate in M.E., but bluejoint and timothy were either marginal or deficient, depending upon the quality of individual samples and the various animal requirements. One lot of bluejoint hay appeared superior in terms of color, time of harvest, curing, and storage and contained 14% crude protein. Nevertheless, the hay was low in M.E. (1.55 Mcal/kg). These laboratory data explain why the stockmen feeding that hay was unable to maintain his sheep without supplemental feeds.

Assuming samples in this survey were representative of the local hays from the Kenai Peninsula region, it appears that a relatively low percentage, 14%, had adequate M.E. levels for steers to gain 1.1 lb per day. None met the requirements for finishing lambs. And only 45% were suitable to maintain dry cows, which have the lowest energy requirements of beef cattle. Compared to possible mineral and vitamin deficiencies, energy shortages in feeds are substantially more expensive and laborious to correct. Therefore, researchers and farmers in Alaska who are concerned with hay quality should give top priority to finding methods for correcting M.E. deficiencies.

Readers must be cautioned against any inclinations to interpret these findings as a basis for discourgaing expansion of Alaska's livestock industry. Metabolizable energy limitations are common during certain periods in other rangeland areas, e.g. Scotland (23) and Idaho (20). Such challenges are being met through research and human ingenuity. The same can happen in Alaska. Consequently, plans for continuing the Homer Beef Production Project include energy studies in forages and the acquisition of a calorimeter for testing caloric values of plant tissues before and after IVDMD digestion in order to define relative M.E. levels more closely.

Monensin sodium, a cattle-feed additive recently approved for both feed lot and pasture usage, is claimed by its manufacturers to increase the energy efficiency in the rumen. The costs are quite minimal and the substance should be tested in Alaska, particularly on native bluejoint hays. Becuase its effects primarily shift rumen fermentation from producing butyric and acetic acids to proprionic acid, monensin sodium is not likely to improve digestibility of forages. It would, instead, decrease energy losses in the portion normally being digested.

Lignin

Lignin is a nondigestible fraction in forages and, to livestock, represents an undesirable component. Heavily lignified (woody) tissues are difficult for animals to digest; hence, lignin lowers metabolizable energy of feeds. Figure 1 shows lignin values determined in this survey for the four major hays. Alfalfa was quite variable and not statistically distinct from the other three hays. Brome was the least lignified of the three grasses. It is evident that lignin and M.E. levels among the three grasses were negatively related.

Since lignin accumulates as plant tissues age, harvesting grasses at early growth stages results in hays with more M.E. than if harvesting were delayed. Also, leaves tend to have less lignin than stems; therefore leafy hays have more M.E. than stemmy hays. Chopping and grinding coarse hays neither reduces lignin content nor increases M.E. Even though such processing may improve the acceptability of the feed to animals, it probably is ineffective in improving the feed's nutritional quality.

Silica

Figure 1 shows the relative content of insoluble silica for the four main hay crops in this survey. It appears that silica content is negatively related to metabolizable energy in this survey. Insoluble silica is believed to negatively affect digestibilities of forages (24). Soluble silica was reported to tie up trace metals such as zinc and copper during laboratory IVDMD trials (18). Both soluble and insoluble silica are probably undesirable hay components.

Silicon is the second most common element in the earth's crust, exceeded only by oxygen. Silicon comprise about 25.7% of the earth's crust (1). Small amounts of silica, a compound of silicon and oxygen, are apparently needed by animals for proper skeletal growth (5). Some plants also require silica for normal growth (6). Soluble silica, absorbed by plants from the soil at the expense of biological metabolism, is referred to as biogenic silica. Silica collecting on plant leaves as dust (non-biogenic silica) is of lesser interest to animal scientists because its effect on forage digestibility is probably minor. Apparently, levels of soluble, biogenic silica change as plant tissues mature (7). Soluble, biogenic silica precipitates inside the plant as insoluble particles. Such particles are called plant opals or phytoliths. How phytoliths reduce forage digestibility is unknown. It is easy to speculate that they encrust plant cells, isolating portions of the forage from rumen microorganisms and digestive enzymes. Unfortunately for ruminants, silica contents of plants are usually highest in leaves and lowest in roots (7).

Alternatives to Hay

Because hay is a major expense to their operations, ranchers in Alaska and elsewhere are always looking for ways to minimize hay requirements. Grazing livestock late in the autumn and early in spring is the most attractive alternative. In Alaska, stockmen have noticed their animals selectively grazing fern, which grows under alder, and seaweed that washes ashore during storms. The nutritional value of those feeds is of interest to stockmen.

Our survey included early spring collections of native bluejoint, dead and live fern fronds and new fern growth (fiddleheads) from a Homer range site and beached seaweed from Kodiak Island and the Homer Spit. For comparison purposes, late-fall collections of two annual plants from Idaho ranges were included, cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsola kali* var. *tenuifolia*). The latter two plants are often sought by livestock in the Northern Great Plains and Intermountain States after frost and following rains during late fall.

Table 3 contains the data from these spring and fall samples. Bluejoint as a standing dead forage plant in early spring had little nutritional value for either livestock or wildlife. The beached seaweeds seemed to be good protein sources, but low in metabolizable energy. Fiddleheads were excellent protein and energy sources on a dry matter basis, but readers should keep in mind that the dry matter level of fiddleheads is probably quite low in early spring. Russian thistle was a good supplier of both energy and protein in autumn, but cheatgrass was low in protein and would provide only enough metabolizable energy for maintaining mature beef animals.

Since native bluejoint ranges, in their highest ecological succession state, often contain few forage plants of consequence other than bluejoint, they cannot meet the nutritional requirements of either wildlife or livestock outside the growing season. Alaskan stockmen whose operations are based on bluejoint ranges have a few alternatives for reducing the annual costs of hay: (1) developing spring and fall pastures on croplands, (2) changing the plant composition of some of their bluejoint ranges to include nutritionally better species for spring and fall grazing, and (3) if none of the above are feasible, they might consider silage operations to complement their hay resources.

CONCLUSIONS

In 1977, metabolizable energy outranked protein as the most common deficiency problem in Alaskan hays. Any improvements in levels of metabolizable energy for hay crops should benefit the local livestock industry. Program plans at the Alaska Agricultural Experiment Station include adding capabilities for caloric measurement to the Palmer Research Center's laboratory. That will assist both applied and basic research programs in Alaska. Agronomic research in silage and hay-making technology, forage crop variety, and soil fertility evaluations should include measures of metabolizable energy. A better understanding of the relationship between soils, forage species, and plant silica is particularly needed for native bluejoint hays.

Digestible crude protein ought to be evaluated along with total crude protein in light of the unfavorable seasonal changes noted with bluejoint. New varieties of adapted grasses, particularly high-producing strains that are being tested by Wm. W. Mitchell, Agricultural Experiment Station, Palmer, merit close watching because they may prove to be good sources for both protein and metabolizable energy.

Chemical curing of standing hay crops in their prime state is an appealing management alternative since proper timing of haymaking is often restricted by weather and shortness of season in Alaska. An acceptable, cost-effective method that preserves both protein and metabolizable energy levels is needed.

Range and pasture for early-spring and late-fall grazing is needed to reduce the Alaskan livestock industry's need for hay. Possibilities for either changing plant composition or chemically curing the standing crop on bluejoint ranges should be studied in concert with monitoring seasonal quality of various native forage species. Developing adapted grasses for improved pastures should be encouraged.

Finally, ranchers still need to know the quality of their own lots of feed before they can properly balance cattle and sheep rations. A routine hay-testing service that inclues both metabolizable energy and protein analyses would be most useful. The current soil-testing service available through the Cooperative Extension Service and the Alaska Agricultural Experiment Station is a model that could be adapted in providing this service in a timely fashion. □

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ACKNOWLEDGMENTS

Financial support for this work was provided by the Alaska Agricultural Experiment Station and by special legislative funding at the request of the Alaska Governor's office. The author expresses appreciation for that support. The ranchers who provided the hay samples for this survey, the technicians at the Palmer Research Center's laboratory who performed the analyses, and Donna Fowler who typed the manuscript deserve credit for their much appreciated assistance with this project.

Gains of Beef Calves during Winter-Feeding and Summer-Grazing Trials on the Lower Kenai Peninsula, Alaska

By F. M. Husby*

Approximately 230,000 acres of potential grazing land occurs on the Kenai Peninsula of Alaska. However, the present grazing leases in the area are only carrying about 700 head of cattle. One of the major problems restricting the expansion of cattle production is the lack of a high-quality winter feed. The most abundant native grass in the area is *Calamagrostis canadensis* (bluejoint) which can yield between one and two tons of dry matter per acre (7). However, this grass as hay is usually of low quality due to rapid maturation. In addition, adverse weather conditions at the time hay quality is high make harvesting difficult (5). Bluejoint has also been reported to be intolerant to heavy grazing or repeated harvests without fertilization (4, 6), although grazing trials have not been conducted to determine the effect of grazing on native bluejoint stands.

The objectives of this study were to determine the cost of feeding beef calves varying levels of average-quality forage during the winter and to evaluate the effect of winter gains on subsequent gains during summer grazing on native bluejoint grasslands.

From June 16 to September 16, calves gained 2.2 lbs. per day on these bluejoint grasslands.

EXPERIMENTAL PROCEDURE

This study was conducted between December 23, 1977, and September 15, 1978. It consisted of a winter-feeding trial to determine weight gains of calves fed varying levels of all forage diets and then subjected to a summer-grazing trial on native bluejoint grasslands to determine the effect of winter-feeding levels on subsequent summer gains.

Winter-Feeding Trial: Thirty Hereford weaner calves (fifteen steers and fifteen heifers) weighing approximately 412 lb. each were randomly allotted to three groups of ten calves on the basis of live weight, sex, and herd of origin. Each group was fed a different amount of hay for a 175-day period. Prior to allotment, all animals were dehorned, wormed, and treated with a pour-on insecticide. Each calf was injected with 1 million IU of vitamin A and 150,000 IU of vitamin D_2 before the start of the trial, with a similar injection repeated in March. Calves were kept in pens with 162 sq. ft. per head including 35 sq. ft. per head under an open-sided shed with 2.5 linear ft. of feed-bunk space per head. Water and a mineral supplement composed of 70% steamed bonemeal or dicalcium phosphate and 30% trace mineral salt was available *ad libitum;* and the hay was weighed and group fed once daily. The three forage treatments were: maintenance, intermediate, and full-feed levels. The maintenance-level animals received only enough hay to maintain live weight over the entire 175-day period while the full-feed animals were allowed access to hay at all times. Live-weight gains and hay consumption were determined weekly. The amount of hay for the intermediate feed level was calculated and adjusted to be fed the next week at a level midway between the quantities consumed in the maintenance and in the full-feed treatments. Initial and final body weights and feed consumption were used to calculate the average daily gain and feed performance for the 175-day trial.

Locally produced timothy hay was analyzed for crude protein (1) and *in vitro* dry matter disappearance (IVDMD) (11). The hay was selected on the basis of a minimum crude-protein content of 8% to provide the level of protein required to maintain the body weight of a 440-lb. calf (8). During the course of the feeding trial, the protein content of the hay was reanalyzed and

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Table 1: Per head nutrient requirements for growing calves and nutrient composition of timothy hays fed during winter-feeding period (175 days)

Weight (lb)	Expected Daily Gain (lb)	Daily Feed Consumption (lb)		Metabolizable Energy (Mcal/lb)		IVDMD[b] (%)		Crude Protein (%)	
		DM[a]	As-Fed	DM	As-Fed	DM	As-Fed	DM	As-Fed
440	0	7.7	8.6	0.91	0.82	57.2	51.5	8.6	7.7
440	1.1	12.8	14.2	0.94	0.85	59.2	53.2	9.8	8.8
Item	Composition of Timothy Hays								
First 91 Days	--	--	--	0.82	0.70	51.3	46.2	7.2	6.5
Last 84 Days	--	--	--	0.92	0.78	57.8	52.0	8.3	7.5

[a] Dry matter.

[b] *in vitro* dry matter disappearance, converted to metabolizable energy as measured in Mcal/lb by the following formula

$$\text{ME Mcal/lb} = \frac{34.2 \text{ DMD } (\%) + 45}{2200} \quad (2)$$

found to be below the minimum requirement, and another lot of timothy was used to complete the trial. The composition of the two lots of hay is shown in Table 1.

Summer-Grazing Trial: At the conclusion of the winter-feeding trial on June 16, 1978, four calves (two steers and two heifers) from each of the three forage treatments were randomly allotted, on the basis of live weight and herd of origin, to two grazing intensities. This procedure evaluated the influence of winter-feeding levels on subsequent grazing gains from native bluejoint grasslands. The two grazing lots were located on Lookout Mountain above Homer and were 21 and 42 acres in size. Approximately 50% of each area was covered with spruce stands or patches of alder. The remaining vegetation was predominately bluejoint. The two lots represented previously ungrazed native bluejoint and, with twelve head per lot, the grazing intensity was 0.87 and 1.75 acres per head for the 21 and 42 acres, respectively.

Live-weight changes were determined weekly until the termination of the 91-day trial on September 15, 1978. Initial and final live weights were used to calculate animal performance. Six calves were kept on pasture at the main station.

RESULTS AND DISCUSSION

The nutrient requirements to maintain body weight or to produce 1.1 lb. of gain on a 440-lb. calf are shown in Table 1 (8), and values are presented for both a dry-matter and an as-fed basis. The composition of the two lots of timothy hay fed during the winter-feeding trial is also shown in Table 1. Timothy hay fed during the first 91 days was low in both crude protein and energy in relation to the requirement to maintain body weight at the estimated daily consumption of 8.6 pounds. Timothy hay from the second lot was slightly below the required levels of energy and protein for body-weight maintenance. The hay utilized in this trial would be considered average-quality grass hay.

Calf performance and cost of gain during the winter trial are summarized in Table 2. The data have been listed by the periods in which the two lots of timothy hay were fed for the total feeding period. The maintenance, intermediate, and full-feed treatments gained 20.6, 71.5, and 129 lb. per head, respectively, over the total feeding period, while the average daily gains were 0.12, 0.41, and 0.74 lb. per head per day, respectively. It is of interest to note that, when the higher-quality timothy hay was fed during the last 84 days, the total gain and the rate of gain was higher for all forage levels than during the first 91 days. The full-feed calves attained an average daily gain slightly greater than 1.0 lb. per day during the second part of the trial compared to 0.48 lb. per day during the first part of the trial. The quality of timothy during the trial was also re-

Table 2. Per head calf gain, feed intake, and cost during winter-feeding period at three levels of forage (175 days, 10 head each).

	Maintenance (days)[a]			Intermediate (days)			Full Feed (days)		
	91	84	Total	91	84	Total	91	84	Total
Ave. initial wt. (lb)	417.5	423.9		415.7	441.0		404.8	448.7	
Ave. final wt. (lb)	423.9	438.1		441.0	487.2		448.7	553.8	
ADG (lb)	0.07	0.17	0.12	0.28	0.55	0.41	0.48	1.01	0.74
Ave. total gain (lb)	6.4	14.2	20.6	25.3	46.2	71.5	43.9	85.1	129.0
Ave. hay consumed (lb/day)	8.28	7.99	8.14	9.22	10.3	9.72	10.88	13.24	12.02
Cost hay[b] ($)			103.33			123.55			152.45
Ave. cost gain ($)			5.02			1.73			1.18
Cost minerals ($)	--	--	3.95	--	--	1.42	--	--	1.85

[a] The total period was 175 days in duration with one quality of timothy hay fed the first 91 days and a higher-quality hay the last 84.

[b] Hay costs were calculated at $0.0725 per lb.

Table 3: Per head calf gains during grazing native bluejoint grasslands under two grazing intensities and following different winter-feeding levels (91 Days)

	Maintenance	Intermediate	Full Feed	Pen Average
		21 Acres		
Ave. initial wt.	438.8	498.8	523.0	486.8
Ave. final wt.	649.8	710.2	702.5	687.5
Ave. total gain	211.0	211.5	179.5	200.6
ADG	2.32	2.32	1.97	2.20
		42 Acres		
Ave. initial wt.	444.0	453.0	557.2	484.7
Ave. final wt.	677.8	653.5	733.8	688.4
Ave. total gain	233.8	200.5	176.5	203.6
ADG	2.57	2.20	1.94	2.24
		Average 21 and 42 Acres		
Ave. total gain	222.4	206.0	178.0	202.8
ADG	2.44	2.26	1.96	2.22

flected in the voluntary intake of the full-feed group with animals consuming only 10.88 lb. per day during the first part of the trial versus 13.24 lb. per day after the quality of the hay improved. Also, the body weight of calves fed at the maintenance level could be maintained with lower amounts of the higher-quality hay.

Approximate gains could be predicted from the hay quality compared to the nutrient requirements in Table 1, and calf growth performance was slightly better than expected. The better-than-expected growth performance could be explained in part by the realization that nutrient requirements are based on average values and contain a safety margin. The data demonstrate that small increases in hay quality gained during the harvest season can have beneficial results in cattle performance. Winter-feed costs for the full-feed calves were approximately 50% greater than the maintenance-level calves but the cost per pound of gain was considerably less for the full-feed group ($1.18/lb) than for the maintenance calves ($5.02/lb). Mineral-supplement costs were greater for the maintenance treatment than for the other two treatments, probably because of increased animal appetite. This cost could be reduced by limiting the amount of minerals given to calves receiving maintenance levels of forage. Worming, vitamin injections, and the insecticide treatment cost $1.10 per head for all three groups.

Calf gains during the summer-grazing trial are presented in Table 3. Total gains and average daily gains for the maintenance- and intermediate-feed calves were greater than gains for the full-feed calves at both grazing intensities. Maintenance-level calves gained slightly more per day on the 42-acre pasture than similar calves on the 21-acre lot, but the gains of the intermediate- and full-feed calves were similar in both lots. Average daily gains of all calves in both lots were similar, 2.20, and 2.24 lb. per day on 21 and 42 acres, respectively. Therefore, native bluejoint grasslands could carry approximately one animal per acre for a three-month grazing season. The greatest daily gains were recorded during the second to fourth weeks of July. However, similar grazing trails are needed to see if the native grassland can sustain this stocking rate over a number of years.

The average gain per calf during the summer-grazing trial was approximately 203 lb. with a daily gain of 2.22 pounds. For comparative purposes, a three-year study of calf gains on the Kansas Flint Hills for the 75 days at peak grass nutritive value reported average gains of 136 lb. per head and average daily gains of 1.82 lb. per head per day (10). Maintenance calves exceeded gains of full-feed calves by about 44 lb. which is considerable when we compare the different initial weights. The ability of animals to gain at a faster rate after prolonged feed restriction has been recognized since 1915 (9) and is referred to as *compensatory growth* or *gain* The reason for the compensatory gain has not been explained, however, it has been noted that cattle are able to utilize energy and protein more efficiently after food restriction. It has been reported that cattle may have a lower basal metabolic rate during and for a short time following feed restriction and that this results in less energy needed for body maintenance and more energy available for growth when animals have free access to unlimited feed (3).

Calf gain and cost during the combined winter and summer trials are shown in Table 4. Only the cost of hay

Table 4: Per head calf gain and cost during the combined winter-feeding period and summer trial (266 days)

	Maintenance	Intermediate	Full Feed
Cost hay ($)	103.33	123.55	152.45
Ave. winter gain (lbs)	22.6	68.4	136.6
Ave. cost winter gain ($/lb)[a]	4.57	1.81	1.12
Ave. summer gain (lbs)	222.4	206.0	178.0
Ave. total gain (lbs)	245.0	274.4	314.6
ADG, 266 days (lbs)	0.92	1.03	1.18
Ave. cost total gain ($)[b]	0.42	0.45	0.48

[a] Ave. cost winter gain calculated as $\frac{\text{cost hay (\$/head)}}{\text{Ave. winter gain (lbs/head)}}$

[b] Ave. cost total gain calculated as $\frac{\text{cost hay (\$/head)}}{\text{Ave. total gain (lbs/head)}}$

was considered a variable since the grazing costs would be a fixed cost per head. Winter and summer gains were combined and charged to the winter-feed costs. This resulted in a relative cost per pound of gain over the 266-day trial in favor of the maintenance level compared to the full-feed level of $0.42 and $0.48, respectively. During the entire trial, the full-feed group gained approximately 69 lb. more than the maintenance group. This would result in a heavier calf for market, but the extra weight would have been achieved by incurring the expense of costly winter feed versus the relatively inexpensive grazing. The relative difference between the full-feed and maintenance group would be less if a more efficient, much cheaper, winter feed were utilized, or if a considerably higher market price could be obtained for the calf. If the grazing season could be extended by utilizing grasslands at lower elevations or by introducing grass varieties that maintain their quality later in the fall, the advantage for winter maintenance levels would become more pronounced.

Steers had better average daily gains during the winter than did heifers at all three forage levels. As the level of hay intake increased, the heavier animals had greater average daily gains than did the lighter calves in reference to the weights at the beginning of the trials.

Although this study over one year has demonstrated that the maintenance of body weight during the winter followed by efficient compensatory gains may be the most economical method of beef production on the Lower Kenai Peninsula, the results should be confirmed with additional trials before major changes in cattle management are implemented. An average daily gain exceeding 2.20 lb. on native bluejoint grasslands compares favorably to cattle gains attained on some of the major grasslands of the "Lower 48." However, further grazing trials are required to determine if these grasslands can sustain the intensive grazing pressure and continue to produce good cattle performance.□

Calf weights were recorded weekly during the summer-grazing trial.

Open-sided sheds provided shelter for the calves during the winter-feeding trial.

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ACKNOWLEDGMENTS

Sincere appreciation is expressed to the Lower Kenai Peninsula ranchers for providing the thirty weaner calves for this study. Funds for this study were provided by the Alaska State Department of Natural Resources, Division of Agriculture.

Managing Native Bluejoint Reedgrass for Forage Production

Wm. W. Mitchell*

Bluejoint reedgrass (*Calamagrostis canadensis*) is the most commonly used native forage grass in Alaska. It is particularly important in the forage program of ranchers and hay growers on the lower Kenai Peninsula, where it occurs in dense, extensive stands.

Prior to research efforts on management of this grass, there was a growing opinion among operators on the Kenai Peninsula that bluejoint should be eliminated from the forage program and replaced with some other grass. This resulted from observations of declining production in harvested fields and from uncertainties about the forage qualities of bluejoint.

Some Canadian workers (1) assigned a low palatability rating to bluejoint but considered it worthy for hay if cut in early July. Early studies conducted with the grass in Alaska (2, 11) demonstrated a sharp decrease in crude protein and an increase of crude fiber through the growing season. A more recent study (8) documented a serious loss of metabolizable energy with maturation.

However, management trials with bluejoint in the Matanuska Valley showed that, with fertilization, annual harvests of 1 to 2.5 tons per acre of medium- to high-protein hay could be sustained (4, 6, 7). These research efforts indicated the grass should be harvested in the boot to head-emergence stage to achieve good yields with adequate quality. Waiting for the highest yields at the fully headed stage resulted in considerable loss in quality. A Canadian trial (3) demonstrated benefits from fertilization and indicated that relatively good production could be maintained with the best balance of yield and quality obtained with two harvests—the first in late June and the second about two months later.

The trials conducted in the Matanuska Valley have been followed by studies on the lower Kenai Peninsula in order to answer better management questions pertaining to that area with its more acid soils and cooler growing seasons. These studies have produced additional information that has encouraged operators to continue with bluejoint as a forage crop.

Bluejoint is well adapted to the acid soils of the lower Kenai Peninsula, does not require liming to maintain a productive stand, is exceptionally winterhardy, and is possibly the fastest-drying forage of those currently available. This last characteristic is important where periods of good haying weather are generally brief. With proper management, bluejoint can make an important contribution to the forage system of a stockgrower or hay producer on the lower Kenai Peninsula and similar areas. The following provides some guidelines for management of bluejoint from the research being conducted on the lower Kenai Peninsula. As is the nature of research, however, it also has raised questions that will be addressed with further studies.

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Figure 1: Bluejoint grassland on the lower Kenai Peninsula in early spring prior to the initiation of growth, illustrating the extremely hummocky nature of undisturbed grassland of this type. A deep layer of litter accumulates at the surface and is underlain with a layer of humic material.

Figure 2: A heavy-duty rotary plow with its deep tilling action eliminated the hummocks and incorporated surface litter and humic material with mineral matter in this bluejoint field. The plowing was conducted in late summer 1972. This picture was taken in spring 1973.

PREPARING GROUND FOR HARVEST

The extremely hummocky nature of bluejoint stands render them unsuitable for machine harvest in their native state (Figure 1). Bulldozers, tillers, brush hogs, and plows have been used to eliminate the hummocks and reduce the thick layer of litter and humic material that occurs at the surface. One of the more successful methods employed a heavy-duty tiller powered by a 250-hp motor, termed a "rotary plow," that incorporated much of the litter and mulch in the mineral soil while eliminating the hummocks (Figure 2) (9).

But how does bluejoint re-establish after a thorough tilling of this nature? The natural return of bluejoint was studied with plots established on ground that had been rotary plowed once in late summer, 1972. The plots were treated with three different fertilizers (8-32-16, 10-20-10, and 20-20-15 of N-P_2O_5-K_2O) at 0, 250, and 500 lbs/acre in 1973 and again in the spring of each of the following three years. Yield measurements were taken with a single harvest each year, 1974 through 1976. Substantial production had been achieved by the second year after tilling, and full production was probably reached by the third or fourth year (Figures 3 and 4). By 1975, the lowest fertilizer rate more than doubled yields over the unfertilized plots.

Additional information was gained from a part of the field adjacent to the experimental plots. After having been rotary plowed in 1972, the field was rotary plowed again in midsummer 1973. It was then disked and harrowed and seeded to annual ryegrass in the fall. The annual ryegrass developed a good stand the following summer and was harvested for forage (fall plantings of ryegrass are not always successful, however). The field was disked lightly again in 1975, broadcast seeded to oats, and harrowed to cover the seed. A bumper forage crop resulted. A planting of oats in 1976, without disking and harrowing, was unsuccessful. Bluejoint had re-established sufficiently in 1976 to merit a forage harvest, and excellent stands have provided a hay crop each year since then. Undocumented amounts of various fertilizers supplying N, P, and K were applied, probably in excess of 500 lbs/acre, each year.

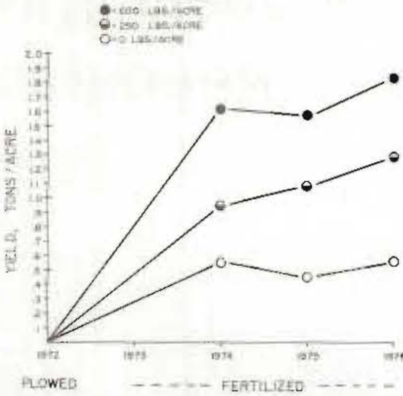

Figure 3: Natural regrowth of bluejoint in hay meadow on lower Kenai Peninsula, Alaska, after thorough tilling with a heavy–duty rotary plow in 1973. Experimental plots were fertilized in 1973 and each year thereafter with three different fertilizers (8-32-16, 10-20-20, and 20-20-15) at rates indicated. Yields shown are averages of the three fertilizer treatments at each rate.

Thus, according to these results, bluejoint is easily re-established without the necessity of reseeding in previously developed stands that have been disrupted for land-smoothing purposes. It also appears that annuals can be grown as intermediate forage crops while the bluejoint is recovering, thereby providing the opportunity to rework the surface. It is unlikely that reseeding of bluejoint will be employed as a means of establishing stands in the near future because of the difficulty of obtaining seed. Only small quantities are obtained with considerable effort from native stands, and very little has been grown for commercial purposes. Because of low seed production, that which has been produced is very expensive. However, the seeds of bluejoint are very small, requiring about 3.7 million to equal one pound (5), therefore, it can be planted at a light rate (2 to 4 lbs/acre) to facilitate the return of a stand.

MAINTAINING PRODUCTIVE STANDS

Management decisions on how best to maintain a stand of bluejoint depend on objectives for the field in question. Among those things that must be considered are: expected yields, number of harvests, and possible use for grazing after harvest.

Without fertilization, yields of .5 to .7 ton/acre were obtained with a single harvest on a field that had been in production for a number of years (Table 1). Applying 500 lbs/acre of 20-10-10 increased yields more than 3.5 times. Withholding fertilizer treatments from previously fertilized plots rapidly reduced yields (Figure 5) indicating there is little long-term carry-over with annual harvesting.

Economics, of course, is a prime consideration in the use of fertilizer, and using 500 lbs/acre of fertlizer to produce about two tons of hay may be beyond the means or objective of an operator. Three levels of fertilizer (0, 250, and 500 lbs/acre) were used in the trial established on the rotary-plowed field, providing some insight into the economics of fertlizer use (Table 2). The 1976 results indicated 250 lbs/acre of 20-20-15 would promote almost as much yield as 500 lbs/acre of the three fertilizers tested. This led to a more elaborate study for more definitive data. Partial results of the first cut in 1978 are presented in Figure 6. Yields in

Table 1. Effect of fertilizer applications and cessation of fertilizing bluejoint hay meadow (single harvest) on Alaska's Kenai Peninsula.[a]

Year	Fertilizer Treatments		
	Never Fertilized (Yield T/A)	500 lb/acre 20-10-10 (Yield T/A)	Not Fertilized in 1975 & 1976[b] (Yield T/A)
1973	.58	2.20	N.A.
1974	.69	2.56	2.55
1975	.53	1.81	1.00
1976	.61	2.19	.76

[a] Yields stated on hay basis (12% moisture).

[b] Plots in this column were fertilized with 20-10-10 at 500 lb/acre in 1973 and 1974, then denied fertilizer in 1975 and 1976. The yield figure for 1973 is not available.

Table 2. 1976 Bluejoint hay yields, with three fertilizers applied at two levels on field that had been rotary plowed in 1972.

Fertilizer Treatments		Yield Tons/Acre[a]		
Lb/Acre	Analysis N-P_2O_5-K_2O			
500	20-20-15	1.89		
500	10-20-20	1.85		
500	8-32-16	1.74		
250	20-20-15	1.60		
250	10-20-20		1.17	
250	8-32-16		1.10	
0				.57

[a] According to statistical tests, figures contained in the same column do not differ significantly at the 1% probability level. Conversely, differences between those figures contained in different columns are highly significant.

Figure 4: Natural regrowth commenced in 1973 on the field that had been rotary plowed in 1972. Sufficient growth developed in 1974 for a harvest and the fertilized plots appeared to have achieved almost full production by 1976, when this picture was taken.

1978 were below those in 1976 for comparable fertilizer levels (Tables 1 and 2), probably owing to a poorer growing season. The higher nitrogen applications (90, 120, and 150 lbs/acre of N) produced significantly higher yields than the lower applications, but the two highest rates were in excess of that needed to produce the highest yields in a one-cut system.

The results of this trial suggest a limit to increasing responses by bluejoint at a relatively low level of added nitrogen. Ninety pounds of elemental N produced the highest yield with this particular fertilizer treatment. More work needs to be done to substantiate this information, but the evidence suggests that 400 to 500 lbs/acre of a fertilizer approximating the 20-20-15 analysis would be the upper limit to apply in a one-cut system. The evidence of two studies also suggests that 150 to 250 lbs/acre of such a fertilizer will produce about .8 to 1.5 ton/acre of hay and that another 200 lbs/acre of fertilizer will add about .3 to .5 ton/acre to the yield. Results will vary according to growing conditions.

Yields can be increased by fertilizing for a second cut. Without adequate fertilizer, a second cut is impractical for bluejoint, both as to amount and quality. According to results over three years, fertilizing at 500 lbs/acre can yield about .3 to .5 ton/acre in a second cut (Figure 7). Refertilizing with nitrogen after the first cut has produced varied results, from having little effect, as in 1975, to adding up to .9 ton/acre to second-cut yields, as in 1974. Refertilization generally had a carry-over effect, thus improving first-cut yields in the following year. This effect diminished over the three-year period with the use of 20-10-10 in the spring application but persisted with 10-20-20. The results suggest that the relatively low phosphorus and potassium contents of 20-10-10 could not meet the demands of the added nitrogen with refertilization.

Differences in growing-season conditions most likely accounted for large differences in yields from year to year (Figures 3 and 6). An excellent growing season was experienced in 1974 while the following year was poor. The heavy demands placed upon the two sites by the lush growth in 1974 may have accentuated the effects of the poorer conditions of 1975.

TIME OF FERTILIZER APPLICATIONS

Results of trials with fall versus spring fertilization have been inconclusive, though there appears to be a trend. Two years' results have been obtained in two different experiments. In the first year for each experiment, fall fertilization has equalled or bettered spring applications (Table 3); but in the second year of each trial, fall treatments have produced from 14 to 18% less yield in the subsequent first cut. Work is continuing on this subject to gain firmer data, but a safe judgment would

Table 3. Yields of fall-fertilized plots of bluejoint in two experiments expressed as a percent of yields obtained in spring-fertilized plots receiving same treatment.

	First Year	Second Year
Experiment A	108%	86%
Experiment B	100%	82%

Figure 5: A drastic reduction in yield was experienced by the plot in the middle foreground because of a cessation in fertilization in 1975 and 1976 (when picture was taken) after being fertilized in 1973 and 1974 with 20-10-10 at 500 lbs/acre. The plots on either side were fertilized each year. The right-hand plot in the background had a similar history.

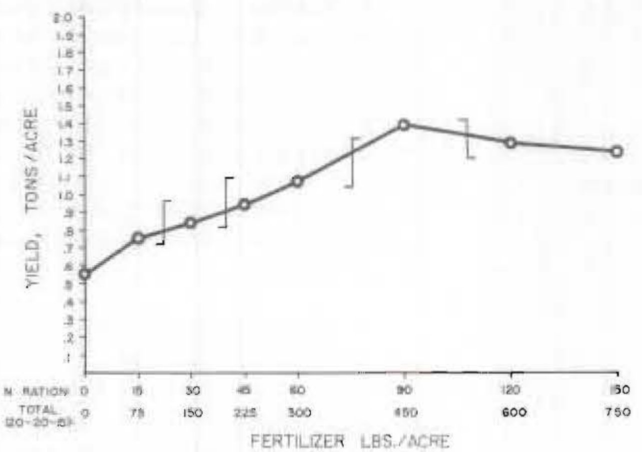

Figure 6: Responses of bluejoint in hay yields to increments of 20-20-15 fertilizer, spring applied in 1978. Points encompassed by each of the vertical lines are not significantly different at 5% level of probability.

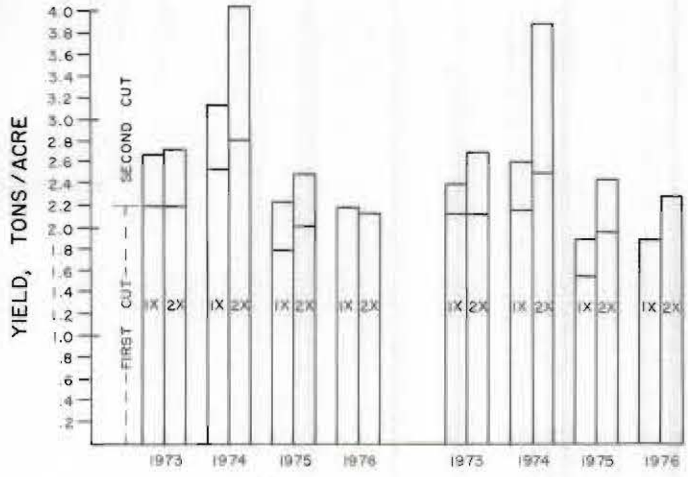

Figure 7: Two-cut hay yields of bluejoint from 1973 through 1976 without (1X) and with (2X) refertilization.

be to expect less yield and decide whether the convenience of fall fertilization is worthwhile. Fall applications may be the answer for fields that are unduly wet for long periods in early summer.

QUALITY OF FORAGE

A stock operator is faced with a number of questions, How much forage can he harvest? and, How good is it? are two critical ones. And the latter often depends on how well he can manage his harvest, that is, whether haying conditions are in his favor or against him.

Because samples from research plots generally are not subject to leaching and weathering in the fields (as hay may be), their analyses gives us a measure of the potential quality of the crop. Bluejoint from first-cut harvests generally has been good to adequate in most categories analyzed for quality (Table 4). Nitrogen contents have been more than adequate with crude protein values (based on % N x 6.25) ranging, as a rule, from about 12 to 18%. Fertilizer treatments with higher N levels raise the nitrogen content of forage. Unfertilized bluejoint, though lower in yield, generally has compared in quality with material fertilized at the lower levels.

A notable deficiency of all bluejoint samples tested is that of calcium content, particularly in relation to the phosphorus content. The National Research Council (10) specifies a calcium level equal to the phosphorus requirement as a minimum. Bluejoint Ca:P ratios from the acid soils of the lower Kenai Peninsula are generally less than .5:1). The Mg content also may be low or borderline. Supplementation of Ca and possibly Mg are necessary for a proper diet for stock feeding on this kind of hay or pasture.

Dry matter digestibility (DMD), measured as *in vitro* dry matter disappearance, and which is directly related to the amount of energy an animal derives from its forage, also may be on the low side. Fertilizers with higher N ratios raise the digestibility of the forage. The importance of this quality may be seen when total hay yields per acre are converted to digestible yields (% DMD x tons/acre hay) as was done in Table 5 using the IVDMD values from Table 4. These data clearly demonstrate the drastic reduction in usable energy in the regrowth (second cut) of unfertilized bluejoint on the lower Kenai Peninsula. Refertilization increased the

Table 4. Percentages of mineral concentration and *in vitro* dry matter disappearance (IVDMD) in bluejoint forage (all first-cut material except where designated) for several fertilizer treatments.

	N (.9-1.5)[a]	P (.17-.21)	K (.6-.8)	Ca (.17-.27)	Mg (.16-.20)	Ca:P 1	IVDMD (54-60)	
0 lb/acre							Cut No. 1	Cut No. 2
Prev. Fert.[c]	1.9	.26	.9	.16	.17	.6	50.8	37.9
Never Fert.	2.3	.25	1.1	.18	.14	.7	53.1	35.1
250 lb/acre								
10-20-20	1.7	.54	2.36	.13	.12	.2	50.3	
20-20-15	2.2	.57	2.09	.12	.21	.2	52.8	
500 lb/acre								
10-20-20	1.9	.59	2.73	.14	.13	.2	52.6	
20-20-15	3.1	.65	2.51	.06	.14	.1	57.0	
20-10-10								
Not Refert.	3.5	.39	1.4	.12	.18	.3	57.6	42.1
Refert.[b]	3.4	.39	1.1	.14	.17	.4	57.6	49.3

[a] Figures in parentheses indicate required amounts for adequate diets with the lower end of range to maintain dry pregnant cows and upper end to produce 1.1 lb/day gain in 440-lb. steer (National Research Council, 1976). A minimum of 1 has been established for a Ca:P ratio (Ca content ÷ P content).

[b] Refertilized plots received, in addition to spring application, 200 lb/acre of urea (45-0-0) after first harvest in previous year and in current year.

[c] Fertilized with 20-10-10 at 500 lb/acre for two years prior to year of cessation of fertilization.

Table 5. **Total hay yields and digestible dry-matter yields (tons/acre) of bluejoint receiving various fertilizer treatments (spring-applied except where noted), ranked relative to the unfertilized first-cut yield.**

	Hay Yield	% Rank.	Digest. Yield	% Rank.	Hay Yield	% Rank.	Digest. Yield	% Rank.
	Cut No. 1				Cut No. 2			
0 Lb/Acre:								
Never Fert.	.53	100	.28	100	.19	36	.07	25
Prev. Fert.[a]	1.00	189	.51	182	.14	26	.05	18
250 Lb/Acre:								
10-20-20	1.17	221	.59	211				
20-20-15	1.60	302	.85	304				
500 Lb/Acre:								
10-20-20	1.85	349	.97	346				
20-20-15	1.89	357	1.08	386				
20-10-10								
Not Refert.	1.81	342	1.04	371	.43	81	.18	64
Refert.[b]	2.03	383	1.17	418	.48	91	.24	86

[a] Fertilized with 20-10-10 at 500 lb/acre for two years prior to year of cessation of fertilization.

[b] Refertilizated plots received, in addition to spring application, 200 lb/acre of urea (45-0-0) after first harvest in previous years and in current year.

digestible yields more than it did the total hay yields. For instance, refertilization (vs. no refertilization) increased the digestible yield of the second cut 33%, whereas the hay yield was only 12% greater.

The information on quality, therefore, states that fertilization with the higher nitrogen levels, besides increasing total yields, raises the N content, thereby increasing the yield of protein from an acre, and enhances dry-matter digestibility, thus increasing the digestible yield from an acre.

SUMMARY

The following data and interpretations apply to management of bluejoint stands for forage production on the lower Kenai Peninsula and comparable areas (soils with pH below 5.5):

Bluejoint stands which can equal 2 tons/acre yield initially, decline to about .5 ton/acre when harvested once annually without fertilization.

Applying 150 to 250 lbs/acre of 20-20-15 or a comparable fertilizer can maintain about 1 ton/acre yield, at least over the intermediate term. Seasonal growing conditions can greatly affect yields.

Higher initial applications of fertilizer or a second application after first-cutting harvest is probably necessary to justify subsequent use of the bluejoint field, either for grazing or a second cut. Regrowth of bluejoint after harvest without sufficient fertilization was low in yield and seriously low in digestibility.

Yield responses to fertilizer increments of 20-20-15 increased on a linear basis to 90 lbs/acre of added N: 225 lbs/acre of fertilizer added about .5 ton/acre yield to the unfertilized production; another 225 lbs/acre of fertilizer added another .5 ton/acre of forage. Yields failed to increase with additions beyond this level. The higher fertilizer rates may, however, increase the amount and quality of regrowth.

Preliminary, inconclusive data indicate that fall applications of fertilizer may result in about 15% less yield than spring applications.

Quality of properly managed bluejoint hay was adequate to good with some exceptions. Crude protein content generally ranged from about 12 to 18%. Phosphorus and potassium were more than adequate, but calcium was deficient and should be supplemented. Magnesium was marginal to barely adequate. Digestibility may be marginal, also. Higher N applications increased protein content and digestibility.

Work is continuing on some of the problems discussed in this paper, and other research in progress by Dr. Winston Laughlin, Agricultural Experiment Station, Palmer, should provide valuable information on the interaction of elements in fertilizer applications and on the effect of sources of nitrogen.□

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ACKNOWLEDGMENTS

A number of persons have assisted in this work. I thank agronomy aides Richard Hill, Peter Scorup, Alan Mansfield, and Keith Poppert; Don Brainard, superintendent, and Jerry Lewis of the Homer Research Station; Gary Michaelson, Janet Barickman, and Vivian Burton for the laboratory analyses; Donna Fowler and Kathy Kendrick for their secretarial services; and others who have been involved on a seasonal basis.

Cool Heads and Warm Feet

D. H. Dinkel*
L. M. Ginzton**
P. J. Wagner***

An environment that promotes hot heads with cold feet is as undesirable in the plant world as it is in the human. We are all aware that temperature has important effects on plant growth, but even professional growers and researchers have questions about the optimum temperatures for root and shoot growth. Most efforts to determine the optimum temperature for plant growth have been related to air-temperature requirements. But we are now learning that many temperate-climate crop plants will function more efficiently if their heads (shoots) are in a relatively cool, sunny environment as long as their feet (roots) are in a warm one.

At first glance, this concept seems contrary to what we have been taught about plant-growth processes. We have been taught that photosynthesis, like other life processes, proceeds faster at higher temperatures. However, this is not always the relationship when ambient air temperature is the standard utilized. The actual temperature of leaves on sunny days may be much warmer than the ambient air temperature, due to absorption of solar radiation. In fact, on warm sunny days, leaf temperatures may reach levels so high that the photosynthesis apparatus shuts down. Some desert plants have effective cooling methods which enable them to function even at high temperatures. However, most of our crop plants do not have this ability, and on warm days too much sunlight may actually be counter-productive for them. Thus, it appears that the ideal situation for maximum photosynthesis is a cool day with bright sunlight both to warm up the "factory" and to provide it with energy to function.

Cool temperatures are also beneficial during cloudy or dark periods. Low temperatures slow down the metabolic processes in the plant and retard the loss of carbohydrates by respiration. Growers are only just beginning to explore the possibilities for improving plant growth and conserving energy by drastically lowering greenhouse temperatures at night. Outdoors, of course, this same drop in temperature at night occurs naturally.

From this we might conclude that Alaska's cool, sunny, long days and short, cool nights would provide an ideal situation for the growth of plants. This does seem to be true for many plants and may explain the phenomenal growth rate of plants such as our huge 'O-S Cross' cabbages. However, some crop plants grown in Alaska, particularly warm-season ones, get cold feet even though they are growing in an otherwise ideal environment. Unlike leaves, which can absorb solar radiation and be warmer than the surrounding air, root temperatures remain very close to that of the soil in which they are growing. If the soil is cold, as it is here in Alaska, the roots are cold—and some plants don't like cold feet any more than people do. Thus, soil temperature can be an important factor in limiting crop growth in the north.

The agriculturist in Alaska needs to design systems that create warmer soil without changing the temperature of the air. We have found great soil-warming benefit from the use of clear polyethylene mulch, raised beds, weed-free cultivation, and other cultural practices. However, the reservoir of cold in

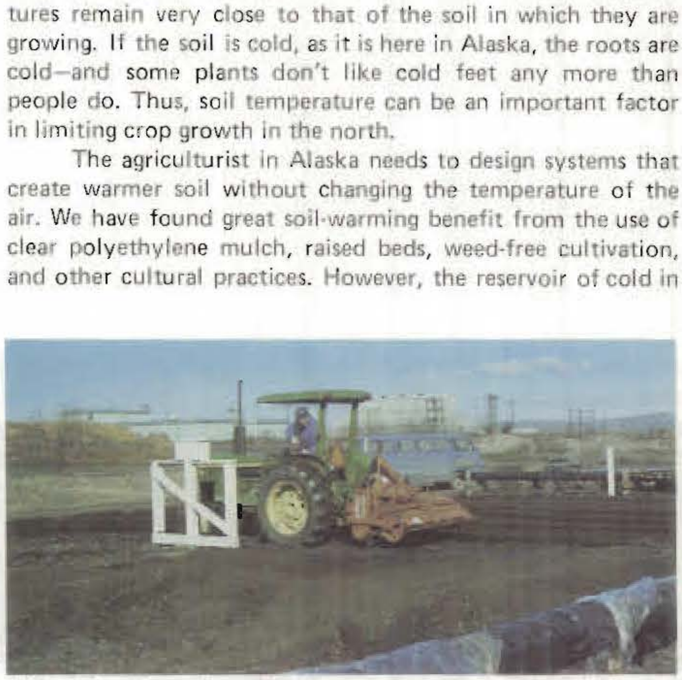

Figure 1: Preparing plots near the Fort Wainwright power plant on April 17.

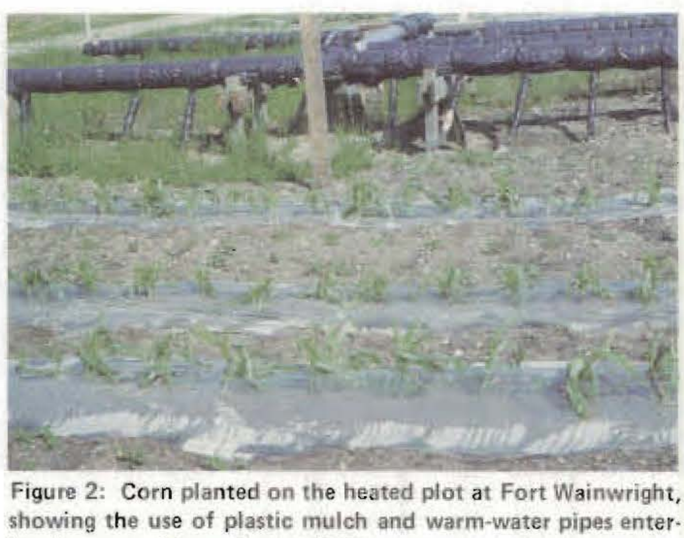

Figure 2: Corn planted on the heated plot at Fort Wainwright, showing the use of plastic mulch and warm-water pipes entering the ground from the manifold.

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Figure 3: Comparison of corn growth on heated and unheated plots in mid-July. Power plant appears behind heated plot.

most Alaska soils is so great that even with these methods it is impossible to attain optimum soil temperatures for some warm-season crops.

The benefits from raising soil temperatures, combined with the knowledge that in Alaska large quantities of low grade heat are presently being wasted, has prompted our efforts to utilize this waste heat for soil warming. Our research has been facilitated by a special legislative appropriation to the University of Alaska for this purpose. This has enabled us to enter into a cooperative agreement with the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), located at Fort Wainwright near Fairbanks.

The CRREL group has been conducting research designed to reduce major pollution problems (mainly ice fog) associated with the cooling pond adjacent to the Army base's electric power generating facility. They are studying the possibility of dissipating the excess heat in ground areas and we are conducting research on the potential of this warm-soil area for the growth of crops. Our research plots adjacent to the cooling pond are heated by warm water from the power plant which passes through buried pipes before being discharged into the cooling pond.

Since a waste-heat utilization system is most efficient and economical if used year-round, we are studying techniques for using this waste heat in the greenhouse as well as outdoors. During fall, winter, and spring, the heat can be used in the greenhouse to warm both soil and air, thus extending the effective growing season. In the summer, less heat is needed in

Figure 4: Interior of University of Alaska greenhouse on March 16, showing tomato plants at left and rosebushes in center. Copper pipes carrying hot water enter soil at far end. Blue cable in foreground carries thermocouples for recording soil temperature.

the greenhouse (although soil warming is still beneficial), so surplus heat can be used for outdoor plots.

As there is no greenhouse facility located near the cooling pond at this time, we are using the University of Alaska's greenhouse on the Fairbanks campus with simulated waste heat. Our design includes a mixing valve and temperature controller so that water of 100°F can be circulated through a buried grid of pipes. Most of the heat in the greenhouse was provided by warm water circulating through the ground. The system was designed to require minimal heat from other sources.

Season extension to improve the quality, variety, and yield of crops produced is the concern of both greenhouse and outdoor studies. The heat requirement is being estimated so that economic evaluations can be made for an industry that may develop here.

In our experimental area at Fort Wainwright we were able to plant the heated plots two to three weeks earlier than the unheated areas. An early planting of vegetables was made April 17 in order to examine the potential for early cropping and for double cropping the same area. We started harvesting our spinach June 9 and completed harvesting the transplanted cool-season crops by July 10. On July 11 we tilled and replanted the plot with the cool-season crops. Table 1 shows the yields from the two successive crops of some of the vegetables grown on this ground. We can conclude that two crops of the longer-season crops such as cabbage, broccoli, cauliflower, and

Table 1: Yields from early and late planting on the same plot (early planting April 17-2l, late planting July 11).

Variety	Early Yield lb/100' row	Late Yield lb/100' row	Total Yield lb/100' row
Green Duke broccoli	130	26[a]	156
Tastie cabbage	270	157	427
Minilake lettuce (seeded)	143	129	272
Pak Choi	--	190	190
Melody spinach	64	30, 30[b]	124

[a] Only terminals were harvested due to thievery of laterals.

[b] Two successive crops planted June 9 and July 21.

Figure 5: A bouquet of 'Cara Mia,' 'Forever Yours,' 'Mr. Lincoln,' and 'Royalty' roses grown in the warm-soil area of the University of Alaska's greenhouse is shown in the photo on the left. The photo on the right shows the flawless beauty of a bouquet of 'Oregold,' 'Golden Fantasie,' 'New Day' (yellow) and 'Royalty,' 'Forever Yours,' and 'Cara Mia' (red) roses.

lettuce can be grown on the same ground. This suggests that, with careful scheduling of crops and planting, the market grower can have his product on the market much longer and can get much greater yields from his heated areas.

Another heated plot and an unheated plot were planted at the normal planting times with both cool-season and warm-season crops. Table 2 shows yield differences for some of the crops. It is easy to see that most crops benefited from the increased soil temperatures. Due to a malfunction of the circulating pump the plots were not heated from May 18 to June 19. We are convinced that the warm-season crops in particular would have shown even greater yields and improved maturity times had the heat been on during that period.

The research in the greenhouse using simulated waste heat also showed great potential. Bare-root rosebushes were planted into the warmed greenhouse soil on February 15 and started blooming on April 15. The cutflowers produced by these plants were of extremely high quality as shown by both storage and vase life and by preliminary test marketing through a local florist. Table 3 shows the production of high-quality cutflowers through October 15, after which production and quality dropped sharply due to low light conditions.

Table 2: Comparison of yields from heated and unheated plots (both planted May 9—June 6).

Variety	Heated plot lb/100' row	Unheated plot lb/100' row
Earlivee sw. corn (pl. mulch)	170	40[a]
Earlivee sw. corn (no pl. mulch)	22	0
Green Duke broccoli (trans.)	178	118
Snow Crown cauliflower (trans.)	138	92
Minilake lettuce (seeded)	133	155
Ostinata lettuce (seeded)	126	108
Melody spinach	163	91
Provider bean	224	105
Green Arrow pea (3' block)	230	110
Zucchini Elite	1,400	998

[a] Some lost to thievery.

Tomatoes and cucumbers were also grown in this greenhouse system. Tomatoes were transplanted into the ground beds February 24 and started fruiting May 18. Cucumbers were transplanted March 6 and began fruiting May 10. The cucumber production was delayed with initial problems with nutrient imbalance. Cucumber yields were 17.9 lb./plant over a 4-month period, so two crops could be grown each season. Tomato production averaged 19 lb./plant. These yields could probably be improved with proper cultivar selection and different cultivation techniques.

Research with heated soil in the greenhouse demonstrates that the potential growing season in Alaska can be extended with the use of waste heat. Greenhouses here are not usually heated in the spring and fall due to the high cost of heat. Given an economical supply of heat, Alaska has an environment for plant growth which is superior in many respects to that found in southern latitudes.

Our research shows great potential for the use of rejected or unused heat from industrial or geothermal sources. This heat can be used to warm the soil and extend the growing season in the greenhouse for production of high cash value crops and also to warm the soil outdoors during the summer for earlier planting, faster growth and increased yields.□

Table 3. Long-stem roses produced per ft^2 of greenhouse.

Variety	Cutflower/ft^2
Oregold	11.1
Royalty	8.7
Golden Fantasie	10.3
Forever Yours	8.2
Cara Mia	7.7
New Day	13.4
Yankee Doodle	12.7
Pirate's Gold	9.4
White Satin	10.2
Ruby Ruffles	14.1
Sonia	8.8
Promise	10.4

The Rampart Agricultural Experiment Station, 1900-1925

A Look into the Past

Frank J. Wooding*

During the period of its existence, the Rampart station was the northern-most agricultural experiment station in the U.S. and, possibly, the world. It was located at 65° 30′ N latitude, approximately 75 miles south of the Arctic Circle (Figure 1). The station was situated on the south side of the Yukon River, across the river from the gold-mining town of Rampart. During the peak mining years, also the peak years of the station, the population of Rampart reached 10,000 people.

Land for the Rampart station was reserved in 1900 and a small clearing of about a half acre was made. Over the years additional land was cleared and buildings erected, and by 1920, approximately 90 acres were under cultivation. In 1906, a five-room cottage was constructed as living quarters for the station superintendent, at that time, Frederick E. Rader. During the next eight years, building construction included two barns, two implement sheds, a combination workshop and grain-storage facility, a root cellar, a propagation house, and a greenhouse. No additional buildings were added after 1914. During the summer of 1925, the station was closed because of the failure of Congress to make an appropriation sufficient for continuing its work (2).

The site of the station was in an area characterized by rolling land among low hills, sloping gradually toward the river. The virgin land was timbered with black spruce interspersed with poplar, birch, willow, and many species of small bushes. Georgeson (2) describes the climate at Rampart as follows:

> The region is characterized by an inland, sub-arctic climate. The winters are long and severe, the summers short and warm, and the rainfall light. The frost-free period averages 97 days. The total annual precipitation is a little less than 10 inches and the rainfall during the growing season averages a little more than 5 inches. There is usually a dry spell during May and June which some years amounts to a drought. The snowfall is variable, usually from 2 to 4 feet, and sometimes as much as 5 feet.

Stump puller at work at the Rampart Station.

GOALS AND OBJECTIVES OF THE RAMPART STATION

From the beginning, research at the Rampart station emphasized grain growing. The following excerpt from the 1910 annual report (2) clearly defines the importance of grain research:

> The original plan for work at this station has been adhered to strictly, namely, the testing and breeding of varieties of grain, at the same time gradually extending the clearing and adding to the equipment until the station is fully prepared for this line of work. The growing of vegetables, the testing of potatoes, etc., are minor experiments.

Between 1910 and 1911, fertilizer experiments were carried out at the station which demonstrated that a lack of soil nitrogen was the most limiting factor, with regard to nutrient requirements, in crop production. Since the small numbers of livestock in the area could not furnish sufficient manure for fertilizing large acreages, and the cost of shipping commercial fertilizers was prohibitive, it was decided that a suitable legume for fixing nitrogen in the soils, must be included in the

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Experimental plots at the Rampart Station in 1909.

crop rotation. In the 1911 annual report (2), objectives for the station are outlined as follows:

1. The testing of varieties of grain, with a view of finding something well adapted to the country.
2. The crossbreeding of grain varieties which have desirable qualities in order to develop grain varieties of greater value than those now known.
3. The introduction, culture, and propagation of hardy legumes.
4. The growing of vegetables on a limited scale, especially potatoes.

The objectives for the station as outlined in the 1915 annual report (2) divided major emphasis equally between grain and legume research. Apparently, the problem of nitrogen deficiency increased with the length of time soils were under cultivation. The following passage best describes the purpose of the station at that time:

> The Rampart station is devoted chiefly to the testing and breeding of grains and legumes. This work is being done so far north because it is believed that varieties originated and successfully produced in the latitudes of Rampart will succeed in all parts of the territory south of the arctic circle.

It is interesting to note that in the 1919 annual report (2) a request was made for funds to clear additional land. The justificiation was as follows:

> The larger area is now needed for increase plots for field tests of hybrid grains that are produced. This is also needed to summer fallow a larger percentage of cultivated ground each year and thus to aid in maintaining fertility.

In 1919, the Rampart station had gone to a cropping system based on summer fallowing. This type of system was destined not to become a popular agronomic practice in the United States for another 20 years.

RESEARCH ACCOMPLISHMENTS AT THE RAMPART STATION

Legumes

Because of the necessity of finding a hardy legume for Alaska, a breeding program with alfalfa was initiated at Rampart. During the early years of the station, a number of different kinds of legumes were seeded. Some, such as white clover and sweet clover winter-killed the first winter after seeding. Others, such as alsike clover and red clover, gradually died out after 2 or 3 winters. Bird vetch and *Trifolium lupinaster* had good winter hardiness but were inferior as hay crops. By process of elimination, alfalfa was selected for crossbreeding work because several types had demonstrated winter hardiness and desirable characteristics for use as a hay crop. *Medicago falcata*, a yellow-flowered alfalfa, had survived even the harshest winters without noticeable winter-kill. However, *M. falcata* did not produce high yields of hay; cuttings of 1.6 tons per acre are reported. On the other hand, 'Grimm', a purple-flowered variety of alfalfa (*Medicago sativa*) produced high yields of hay but lacked winter hardiness. Hybridization work involved crossbreeding *M. falcata* and 'Grimm'. Although a number of hybrids were produced, none proved to be hardier than the parent, Grimm. The yellow-flowered type (*M. falcata*) was the only alfalfa that proved absolutely hardy (2, 4).

Grains

The success of the grain research program at the Rampart station can be described best by quotations from annual reports prepared by C. C. Georgeson, Special Agent in Charge of Alaska Agricultural Experiment Stations.

> 1906: Grain has matured every year since work was begun in 1900.
>
> 1908: Grain crops at Rampart were all that could be wished. Out of 67 varieties of grain grown in 1908 only 2 failed to mature. This station, which is less than a degree from the Arctic Circle, has been the most successful grain-growing station. Grain growing is the most important work at this station.
>
> 1909: It is a great satisfaction to again report the work at the Rampart Station an unqualified success. Fifty-five varieties of cereals matured at this station the past summer.
>
> 1913: The success of Rampart Station has been almost phenomenal. There has never been a failure of more than a few late-maturing crops at this station, and even last year, with the severe freeze, all important crops matured.

During the early years of the station, grain research was confined primarily to the testing of varieties introduced from other areas and the selection of desirable heads in hopes of improving existing varieties. A total of 147 introduced varieties of barley, oats, wheat, and rye were evaluated during the life of the station. Work with crop rotations and soil fertility was done on a limited scale (2, 3).

Barley grown at Rampart in 1907.

George Gasser arrived at the Rampart Station in 1907 and initiated a grain crossbreeding program aimed at the development of hybrids (See: *George T. Gasser: A Brief Biography*, this issue). At first, the hybridization program dealt entirely with barley, but later it was expanded to include wheat and oats. Of the three, barley hybridization was the most successful. Of course, more emphasis was devoted to barley because of its greater adaptability to northern environments. Although many hybrid barleys had desirable characteristics, none of the initial crosses were stable enough for release as new varieties. Eventually, stability was obtained in one hybrid and it was released under the name of 'Trapmar', which is Rampart spelled in reverse (2, 3). This variety proved to be highly successful and was grown in the Tanana Valley and other areas of Alaska for many years.

'Finnish Black' oats was a particularly successful variety at Rampart.

Oats was considered the second most important grain crop for interior Alaska (2). Although a number of varieties performed well, repeated reference is made in annual reports to a black-hulled introduction from Finland named 'Finnish Black'. This variety proved to be the earliest maturing oat grown at all the stations (2, 3). Little mention is made in the literature of the oat hybridization program. Apparently, no oat hybrid was developed that showed improvement over existing varieties.

Oat hay at Rampart yield 2½ tons per acre.

Several winter-wheat varieties were tested at Rampart. 'Karkov', of Russian origin, was by far the hardiest variety, but averaged only about 25% winter survival over a number of years. Selected kernels from the small proportion of surviving plants were repeatedly seeded year after year in the hope of

Grain in shock at the Rampart Station in 1908.

developing a hardy strain. However, no improvement was obtained in hardiness (2, 3).

Prior to 1914, spring wheat was considered a marginal crop for the Rampart area. It failed to reach maturity about one out of every four years. The recommended varieties at that time were 'Romanow' and 'Ladoga', both of Russian origin. In 1913, samples of a number of spring wheats were obtained from the experiment station at Tulun, Province of

Fall plowing, Rampart, 1907.

Irkutsk, Siberia. Among them was the variety 'Khogot', afterwards erroneously, but phonetically, spelled 'Chogot', and then referred to as Siberian No. 1. Siberian No. 1 was the earliest variety of spring wheat tested at all the Alaska stations, maturing in as few as 84 days at Rampart (3). After four consecutive successful years of growing Siberian No. 1, George Gasser stated in 1917: "Wheats have progressed so they are feasible (2)." Yields, on a field scale, of 20 to 30 bushels per acre were frequently reported (3).

The spring-wheat hybridization program at Rampart, although it continued for almost 10 years, was unable to produce a variety having characteristics superior to Siberian No. 1. The inability to transfer early maturity in the crosses is cited as the principle reason for the lack of success (6). In 1921, George Gasser was transferred to the Fairbanks Station where he continued his work with wheat. Eventually (years after Gasser's retirement), a hybrid wheat superior to Siberian No. 1 was selected from materials originally worked on by Gasser. This wheat was released in 1953 and was named 'Gasser' (5).

Spring rye did not mature early enough to be grown at Rampart. Several varieties of winter rye were grown successfully for a number of years and all were hardy when the field was covered with an adequately insulating layer of snow. The Russian variety 'Hogot' was superior to all others tested (2, 3).

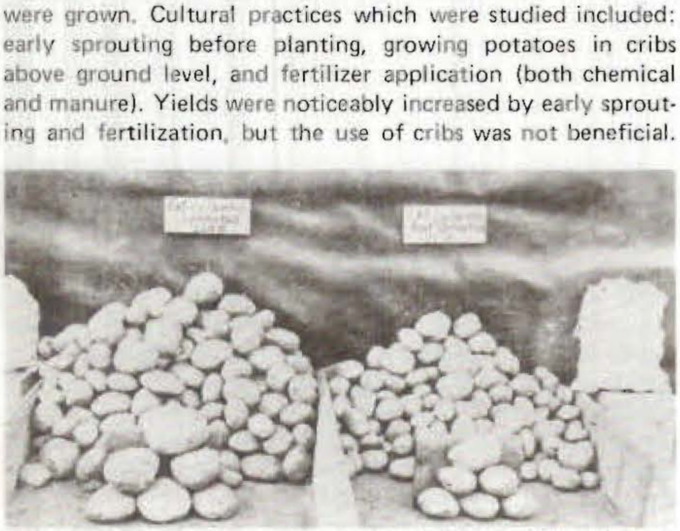
Grasses

Perennial grasses were evaluated for winter hardiness and use as hay crops. Smooth bromegrass proved to be the best grass grown at the Rampart Station. It was a good hay producer and survived the winters. Meadow foxtail was ranked as the second-best grass and was recommended as an early hay grass. Redtop, velvet grass, perennial ryegrass, and reed canary grass winter-killed the first winter after seeding. Kentucky bluegrass, meadow fescue, and timothy gradually died out after several winters. Tall meadow oatgrass and orchard grass survived the winters but were poor hay producers (2, 4).

Potatoes

Potato research at Rampart (2) included variety testing and development of cultural practices to improve yields. Variety testing was done on a limited scale, usually involving the evaluation of one or two new varieties each year. The years 1908 and 1909 were an exception, when a total of 35 varieties were grown. Cultural practices which were studied included: early sprouting before planting, growing potatoes in cribs above ground level, and fertilizer application (both chemical and manure). Yields were noticeably increased by early sprouting and fertilization, but the use of cribs was not beneficial. Yields ranging from 12 to 17 tons per acre were obtained when potatoes were planted on highly manured land.

Early Eureka potatoes at Rampart, 1910.



Gold Coin potatoes, sprouted (left) and not sprouted (right), in 1910 at Rampart.

Vegetables

Although vegetable research was not a major goal of the station, each year a number of types and varieties were tested in the station superintendent's home garden. Their success or failure was included in annual reports (2). The following vegetables were successfully grown year after year:

Peas	Radishes	Green pod beans
Table beets	Lettuce	Yellow wax beans
Carrots	Spinach	Kohl-rabi
Rutabaga	Mustard	Cabbage
Turnips	Swiss Chard	Kale
Broccoli	Onions from sets	Parsley
Rhubarb		

Some vegetables performed well in years when the growing season was favorable but did poorly or failed other years. The following vegetables might be classified as marginal:

Parsnip	Cucumber	Celery
Tomato	Cauliflower	Brussels sprouts
Onions from sets	Eggplant	

Fruits

Various fruits were tested on a limited scale at Rampart, including apple, crabapple, red raspberries, red currants, and strawberries. Apple trees survived several winters but never produced fruit. A Siberian crab-apple produced two fruits one year. Raspberries and currants were moderately successful, although yields were generally poor. Strawberries were by far the most successful of the fruit crops. Hardy strawberries, originating from the Sitka Station in southeast Alaska (no longer in operation), produced firmer and sweeter fruits when grown at Rampart (2).

EPILOGUE

The Rampart Station was officially closed 55 years ago. During the span of its operation, it was one of the most successful experiment stations in Alaska. Since then, higher-yielding, earlier-maturing varieties of many crops have been developed for Alaska. Commercial nitrogen fertilizer (urea) is now produced in Alaska, and techniques are available for growing warm-season crops (including use of clear polyethylene mulch). In the case of winter wheat, there are a number of varieties which have greater winter hardiness than 'Kharkov', the best variety at that time.

Today, little remains of the Rampart Station. Small trees are growing where open fields once lay. Vetch, alfalfa, and strawberry plants now grow wild. During the 1940s the buildings were torn down and the lumber was used for construction of a school in the town of Rampart. Now, all that remain are their foundations. The population of Rampart has declined steadily until, now, there are only 34 permanent residents.□

Editor's Note: The photographs included in this article are reprinted from several annual reports of Alaska Agricultural Experiment Stations published from 1907 through 1910.

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George T. Gasser
A Brief Biography

Sig Restad*

George Gasser had been retired for five years when I first met him in 1958. At 79, he still attended regularly the weekly meetings of the Fairbanks Chamber of Commerce and held the position there of Chairman of the Agricultural Committee. His health was failing so he could not be very active, but "Doc," as he was known to most, stayed on as chairman as a tribute to the over-50 years in which he participated actively in the development of agriculture in Alaska.

George Gasser graduated with a Bachelor of Science Degree from Kansas State Agricultural College in 1905 with a major in Agronomy, and on August 5, that year he started his work in Alaska as Assistant Superintendent of the Rampart Agricultural Experiment Station under Superintendent Frederick E. Rader. This was the farthest north of several stations started in Alaska after glowing reports of successful gardens in the territory reached U.S. Secretary of Agriculture Wilson in 1897.

These included a headquarters station which was started at Sitka in 1898, followed by stations at Kenai in 1899, Rampart in 1900, Copper Center in 1902, Fairbanks in 1906, Kodiak in 1907, and Matanuska in 1917. These early stations were carved out of the wilderness with a minimum of finances and equipment—as George found out at Rampart. He succeeded Frederick Rader as superintendent in 1908 and under his direction, eight acres were cleared with the aid of one team of horses. This doubled the station's cropland, and Experiment Station reports praised Gasser for the clean, weed-free, well-managed plots he kept.

During his stay at Rampart, which lasted until 1920, George managed to keep up with variety testing, perform crossbreeding of small grains and legumes, raise garden seed for distribution throughout interior Alaska, work with small fruits, develop land clearing guidelines, amass a virtually complete plant collection of species indigenous to the area, increase the cropland to 90 acres, and manufacture his own power-driven threshing machine.

The population center of interior Alaska and the area of most activity developed around Fairbanks in the early 1900s and, in 1915, the U.S. Congress granted four sections of land for an Agricultural College and School of Mines.

George Gasser was a firm supporter of an Agricultural College for Alaska and worked toward its inception with Dr. Charles Bunnell, who was to become the first president of the Univeristy. In 1917, the Alaska Territorial legislature created the "Alaska College of Agriculture and School of Mines" and appropriated $60,000 for construction.

In 1920, George Gasser was transferred as assistant in charge to the Fairbanks Agricultural Experiment Station, where more agricultural activity existed. Fairbanks had its own flour mill capable of milling 25 barrels of flour per day and over 100 homesteads with agricultural problems that needed solving.

The first graduate of the new college in 1921 was John Sexton Schanley who had transferred from Cornell in 1919 when courses first started. He homesteaded land next to the campus like many other students, and after graduation ran a seed business for sometime. This property is just below the university where a bank and the intersection of College Road and University Avenue are now located. Dr. Gasser bought Schanley's homestead and lived there until he died.

In 1925 and 1926, Doc did more graduate work at California and then became Professor of Agriculture at the College in 1927. He brought to the College twenty-one years of Alaskan agricultural research experience gained at the Rampart and Fairbanks Stations as well as the wide contacts he had developed in working with Alaskans. By this time he had developed 'Gasser Wheat', a variety superior to any to be found for interior Alaska for the next half century. He was director of the College Glee Club, worked with many community activities, and could always be counted on for providing leadership in setting up the agricultural exhibit at the Tanana Valley Fair.

Doc found time for some activities outside of the experiment station and college also. He was in partnership with

Dr. George T. Gasser

a commercial greenhouse in downtown Fairbanks on the property where the Fairbanks Traveler's Inn now stands.

By 1936, George became Dean of Men on the Fairbanks campus and head of the College Department of Agriculture in 1937. In 1946 Doc Gasser was appointed the first Commissioner of Agriculture for the Territory of Alaska. Under his leadership, the territory established laws and regulations for improved marketing standards, animal health regulations and policies, aid to agricultural fairs, and a general-development attitude on the part of the territorial government.

He was one of the state personnel that accompanied a Federal agricultural task force that toured Alaska in 1947 in order to review the possibility of Alaska's developing a more self-sufficient food base. One outcome of that task force was the establishment of the U.S.D.A. Alaska Agricultural Experiment Station at Palmer.

George Gasser retired in 1953 but remained in Fairbanks. He remained enthusiastic as his health would allow until his death in 1960. A crowded funeral service on a winter day at about 30 below in a little Fairbanks church demonstrated that the community had not forgotten an Alaska pioneer that spent a lifetime trying to improve Alaska's ability to care for herself. □

Editor's Note: Photos of Dr. Gasser on this page and on page 3 are from the Dr. George Gasser Collection, Archives, University of Alaska, Fairbanks.

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Iceland
Productive Northland

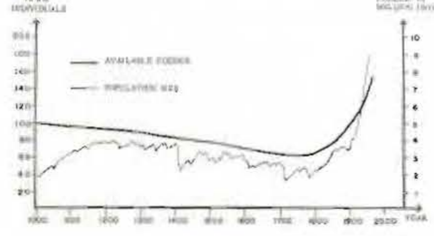
Wm. W. Mitchell*

Editor's note: The author spent from August 27 to September 2, 1977, in Iceland on special funds provided by the Alaska legislature to the Division of Agriculture to promote exchange of plant materials and information with northern countries. The following account is based on observations and information gained on this trip and on material obtained from the references.

Figure 1: Remnant stands of small birch trees have persisted on the higher pedestals in the background while, in the surrounding area, several feet of soil have been eroded away through over-grazing and wind action. Natural revegetation is in progress.

Iceland is a volcanic island about 40,000 sq. miles in size, lying between 63.5° and 66.5° N latitude, on a par with boreal forested regions of Alaska and Canada. Oceanic influences and historical events limit Iceland's native plant cover, however, to maritime grasslands, shrub lands, and small birch stands. Iceland bears striking similarities to portions of Alaska's Aleutian Islands and contiguous southwest coastal region. Summers are cool with about three to four growing months. July, the warmest month, averages about 52°F. Winters are long but not excessively cold; February, the coldest month, averages just below freezing. Annual precipitation varies a great deal, 19 inches, at a northern station, to 90 inches at a southern coastal station.

Iceland was first settled in 874 A.D. In 300 to 400 years, it achieved a highly developed rural culture and remained essentially a rural society until this century. By 1200 A.D. it supported about 80,000 persons and for a number of centuries sustained about 6,000 to 7,000 farms. But history speaks of many periods of famine resulting in a reduction in population. Icelanders apparently experienced a decline in farming ability resulting in substantial soil erosion and reduced soil fertility. Frequent winds eroded the highly susceptible volcanic soils, whose vegetation had been overgrazed, and completely denuded some productive areas. These factors coupled with unfavorable climatic conditions and volcanic eruptions brought the population to less than 40,000 in 1780. The decline in population, however, was reversed in the beginning of the 19th century by a revival of soil cultivation practices and a warming climate. Dr. Sturla Fridriksson, who has researched Iceland's grasslands, relates the island's population trends to its fodder-producing capacity (see graph).



Only 40 to 60% of the island was vegetated originally and erosion is estimated to have reduced that portion to less than half of its former area. Thus, today most of Iceland is unvegetated, consisting of glaciers (11%), barren highlands above 2,300 ft, recent laval flows, rock deserts, gravel outwashes, and eroded areas. Whereas about 25% of the island was once covered with small trees and shrubs, today only 1% is so clothed.

Figure 2: Hot springs and geothermal sources are tapped for energy to support a thriving greenhouse in Iceland.

Figure 3: Geothermal sources supply the hot water for the heating system of Reykjavik; steam emits from the outlet pipe in the foreground. Reykjavik, once grimy from oil burning, is a clean, bustling capital city.

An active program is underway to reclaim part of the eroded land, and plants of Alaskan origin are contributing to this effort. Alaskan plants also are used for landscaping purposes. Icelandic organizations involved in the reclamation program include the Agricultural Research Institute, Soil Conservation Service, and Forest Service. Private citizens also participate.

Despite the loss of land to erosion, Iceland is an exporter of meat and dairy products after providing an ample amount for its own use. Hot springs and subterranean hot water are exploited for a flourishing greenhouse industry. About 37 acres are under glass with tomatoes, cucumbers, and flowers the principal products. Some other vegetables are grown under glass and in the field. Potatoes are the main field-grown vegetable, but some must be imported to satisfy the country's needs.

Figure 4: Iceland's highlands, subject to frequent strong winds, have remained unvegetated. An area of moon-like landscape, such as this, was utilized for training American astronauts involved in the moon-landing program.

The name "Iceland" somewhat belies the true character of this island nation. Glaciers and a northern oceanic climate are prominent features, of course. But volcanic processes and frequent winds are important factors shaping much of the Icelandic landscape. At least 30 volcanoes have erupted since the settlement of the island. Barren laval beds, some of them

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moss and lichen covered, present a stark beauty of their own. Wind-carved deserts that have driven farmers off their land encroach on vegetated lowlands. Despite the abundance of bleak landscapes, Iceland's lush green valleys, dissected by clear streams and rivers with attractive falls, and its green slopes, interrupted by rock cliffs, afford lasting impressions. Forage fields, grazing paddocks, and rangelands support populations of sheep, cattle, and horses. Probably the most striking difference between Iceland and similar areas of Alaska is the highly productive use to which Icelanders have put their land. Still, some large expanses of rangelands are only sparsely populated. And unvegetated highlands, laval beds, and glaciers constitute a wilderness of their own.

Figure 5: Neat, productive-looking farms dot Iceland's lowlands. Native range (foreground) and improved pasture and hayland (background) support this sheep operation. Note the drainage ditches and concrete construction of the farm buildings.

Farming Operations

Sheep and dairy operations are the main farming enterprises. Iceland supports more sheep per capita than any other European country. About 1 million animals are overwintered, but the capacity of the rangelands to sustain this number is in question. Improving lamb growth on the lowlands, which have not provided the gains expected from their relatively lush growth, is a major goal of research.

Iceland maintains its own breed of sheep derived from animals brought in by the early settlers. Sheep numbers increased from a general low of about 200,000 in the late 18th century to about 500,000 in the late 19th century. Modern improvements have enabled further increases to almost 1 million, although around 1950 much of the island's sheep population was necessarily destroyed because of a lung disease introduced by imported sheep. Now the importation of animals and meat products is prohibited. The Icelandic breed belongs to the North European short-tailed race which possesses a double

Figure 6: While grazing on the range, sheep are seen singly or in small groups, rather than large bands. The Icelandic breed is derived from early introductions from northern Europe and has a fine, downy undercoat and coarse, longer outercoat.

fleece—a fine, downy undercoat and a coarse, longer outercoat. Woolen pelts are exported and Icelandic-made woolen garmets are in strong demand in foreign markets. Lamb and mutton are also export items.

Icelandic ewes average about 133 lambs per 100 ewes, and meat production per overwintered sheep equals about 35.2 lb. The lambs are slaughtered from mid-September to late October after the sheep are gathered for their winter quartering. The sheep are grazed on cultivated pastures in early spring prior to being placed on grazing commons, or rangelands. The lambs are grazed on cultivated pastures in the fall to improve their gains prior to slaughter. Overwintering animals are brought to the farm buildings and provided housing for the six-month winter period. Flocks on ranches devoted exclusively to sheep raising vary from about 200 to 800 animals. Smaller numbers are found on mixed operations. The sheep generally move about singly or in small groups, rather than large bands, during the grazing season. Having no serious predators to guard against, the island sheepmen are without a major concern that affects most operators in North America. Icelandic dogs are used to help in the gathering.

Figure 7: Dairying is the largest economic factor among farming enterprises. As with the sheep, the Icelandic breed of dairy cow is derived from early introductions, mainly from Norway.

Dairying is the largest economic factor among farming enterprises and provides considerable produce for export. Cattle numbers total about 65,000, the bulk of which are dairy animals. Beef raising is a small factor but there are plans to enhance beef production using imported Galloway cattle. Milk cows yield about 8,250 lbs. of milk per year. As with the sheep, the dairy stock is an Icelandic breed derived from early introductions, mainly from Norway. It is a light-framed, thinly fleshed animal, relatively poor for beef production. Breeding efforts and improved cultural practices have increased milk production dramatically in recent years. Most of the dairy herds are artificially inseminated with semen from progeny-tested sires. Two bull centers and 10 subcenters for A.I. are maintained in the country. Over 80 local breeding associations have been active in the program.

Figure 8: The Icelandic pony is a short, stocky animal that served both as a draft horse and "cow pony" in the past. It is still used for herding and gathering and is highly prized as a show and recreation animal. The Lutheran church (background) is a state church.

The Icelandic pony, of which the Icelanders are very proud, also is maintained as a pure breed. It is a short, stocky animal, tough and hardy, that has performed yeoman service over the years. The animal is used for herding and gathering, formerly as a draft horse, as a meat animal, and, in increasing numbers, for show and recreation. Today, breeding efforts are mainly for the last-named purposes. Riding ponies also are an export item.

Only a small number of swine are raised in Iceland. The lack of grain production militates against hog raising. A small number of reindeer are maintained in the eastern part of the island.

Poultry numbers also have been low because of the grain production problem. But with a growing urban market for eggs, poultry raising is on the increase. Research is underway to substitute grass meal for grain, thus enabling increases in the pork and poultry industries.

Similarities to Alaska are reflected in some of the auxiliary sources of income for farmers. Some farmers bolster their incomes with fishing, seal hunting, collection of eider down, hunting and gathering of eggs from wild birds, and driftwood collecting. Certain farmers and property owners can realize income from fishing interests in a manner not open to Alaskans. Property owners may own the fishing rights along streams traversing their property and lease these rights to paying fishermen. Some go for high prices to anglers from the U.S. and other areas.

Forages and Grasslands

Iceland's capacity for growing grass and affording a nutritive feed through the growing season are the basis for the sheep and dairy industries. Chemical fertilization has made possible more intensive use of smaller tracts of land and has provided large increases in forage production. Fertilizer is applied both on forage fields and on select grazing areas. About 100 lbs. of nitrogen plus 50 lbs. of phosphate and 20 lbs. of potash are applied per acre to many of the fields. Some of the nitrogen fertilizer is supplied by a factory producing ammonium nitrate near Reykjavik.

The principal native grasses found on ranges in Iceland are red fescue (*Festuca rubra*), tufted hairgrass (*Deschampsia caespitosa*), bluegrass (*Poa pratensis* and *Poa* sp.), bentgrasses (*Agrostis* sp.), and reedgrasses (*Calamagrostis* sp.), plus sedges (*Carex* sp.) in the poorly drained situations. Native grasses usually cut for forage consist of red fescue, tufted hairgrass, and Kentucky bluegrass.

Perennials generally seeded for harvest or pasture consist of red fescue, Kentucky bluegrass, and timothy. Annual ryegrass, oats, and kales provide most of the annual forage crops. Perennial fields are generally cut once with the regrowth used for grazing. Intensively managed fields can provide two cuts. Production in the fertilized fields equals 1.35 to 2.25 tons/acre. Considerably higher yields have been obtained in experimental plots.

Intensive research is underway at Iceland's Agricultural Research Institute to breed or find new grasses, cereals (oats and barley), and legumes that may be used in Iceland. Work also is in progress to develop means for producing seed on the island, as most seed now is imported from the Scandinavian countries. A potential seed industry in Iceland must cope with a relatively short, cool growing season, and wet, windy conditions during the harvest period. Alaska is better situated regarding seed production, having the ability to satisfy its own seed needs for grains and many of its grasses, although currently there are too few qualified growers in Alaska to satisfy these needs.

The storage of good-quality hay is abetted on many of the Iceland farms with the use of hay-drying equipment. After a day or two of field curing with turning, the drying is completed in the barn with an air-blowing system. Cut forage also may be stored as silage, generally in tower silos. On many farms, grass is picked up in the field with forage wagons that resemble old fashioned hay racks equipped with a mechanical pickup and unloading system. A mower with a number of individual cutting pieces mounted at the base of revolving drums does an efficient job of cutting and swathing.

Pelleted feed is produced on the island by five large and three small plants. Grasses grown for these plants include both annuals and perennials, principally annual ryegrass, oats, and timothy. One of these plants operated by the Iceland Soil Conservation Service produces almost 13.5 English tons per day. Its operation requires 1.85 gal. of crude oil per minute. About 40,000 tons of concentrates are imported for supplemental feeding, mainly for dairy animals.

Figure 9: Thorsteinn Tomasson (left) and Andres Arnalds (right), range specialists with the Agricultural Research Institute, view some research on seed production with Icelandic red fescue and bluegrass. Frequent winds, in existence here, complicate development of a seed production industry on Iceland.

Land Reclamation and Landscaping

Though Iceland currently is not in a land bind, the nation is confronting the inevitability of growth coupled with the constant threat of erosion. Erosional processes are reducing the amount of land capable of supporting livestock and of providing for parks and reforestation. Iceland's population is expected to grow from 200,000 in 1972 to almost double

Figure 10: The Icelandic Soil Conservation Service has reclaimed about 300 acres of land in this glacial outwash valley, which was only sparsely vegetated (center and left) prior to reclamation.

that figure by the end of the century. In order for Iceland to remain self-reliant for its livestock products, forage production must be increased by substituting cultivated land for some rangeland. Furthermore, erosional processes must be checked as much as possible.

The Icelandic Soil Conservation Service is actively engaged in land reclamation activities and in providing services to farmers for upgrading their operations. Fences are used to protect some sensitive areas from animals, and grazing practices are more closely monitored to maintain a thrifty growth on rangelands and improve on plant composition. Some sand dune areas have been seeded to a beach grass, *Elymus arenarius*, which is closely related to dune wildrye (*E. mollis*) that occurs along Alaska's coastline. Barren rangelands have been reseeded, mainly with red fescue and Kentucky bluegrass, and others improved with fertilization. The Soil Conservation Service established its main headquarters in a severely eroded area that had been abandoned by farmers; with seeding and fertilizing it has developed a highly productive operation supporting a large number of livestock, forage fields, and a grass-pelleting plant.

In one of several efforts, about 300 acres of a broad, glacial, gravelly river bottom has been reclaimed with the red fescue/bluegrass mixture and annual applications of 26-14-0 fertilizer at 356 lbs/acre. The area provides late summer grazing for sheep that are brought in from the grazing commons earlier than usual. Some of the grazing commons also are fertilized at the above rate. These practices have enabled the farmers who participate in the program to increase their sheep numbers while lessening the pressure on the range, thereby increasing its productivity. The seed and fertilizer have been applied aerially with a DC-3. Where feasible, the Soil Conservation Service provides the aerial application service for cooperating farmers who purchase fertilizer for their rangelands. Those areas seeded to imported grasses require more frequent fertilization than native grasses, however, to maintain adequate stands. The imported grasses often disappear after five years. Farmers also are adding some important acreage to their cultivated land by draining peatlands dominated by sedges. Drained boglands can become productive forage fields or improved pastures because of changes in species composition.

The Icelandic Agricultural Research Institute is pressing its research on native grasses and other introduced grasses and legumes to improve on what is currently available. Because of common interests at comparable latitudes, a healthy exchange of plant materials has taken place between workers of the Icelandic Institute and the Alaska Agricultural Experiment Station. Promising results by Institute workers with an Alaskan entry of Bering hairgrass (*Deschampsia beringensis*) has led the Icelandic Soil Conservation Service to order a quantity of seed for further testing in larger plantings. The seed is being produced at the Alaska Plant Materials Center at Palmer in cooperation with the Experiment Station. It is of interest that this same grass performed well in trials conducted by the author on Amchitka Island of the Aleutian Chain and was used by ERDA in their revegetation seedings after the nuclear test series on that island (3). Benefits of the exchange with Iceland have not been one way, because grass materials received from Iceland are of interest to the Alaskan workers.

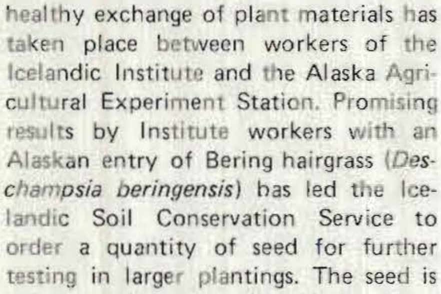

Figure 11: Aerially seeded with a mixture of red fescue and Kentucky bluegrass and fertilized, this gravel outwash now supports a lush growth and provides late summer grazing for sheep that are brought in from rangelands earlier than usual.

The Icelandic Forest Service has found good use for Alaskan Sitka spruce and poplar in its efforts at forestation and landscaping. Sitka spruce and other trees that are grown in nurseries are widely distributed to Icelandic citizens who are intent on establishing hedges and trees on their premises. Parks in Reykjavik are adorned with healthy stands of Sitka spruce and other trees. Another Alaskan plant used in reclamation efforts on Iceland is the lupine *Lupinus nootkatensis*, a leguminous nitrogen fixer, first introduced from collections made at College Bay, Alaska. It is considered to have high potential for reclamation work.

Figure 12: Andres Arnalds, wearing one of the famed Icelandic woolen sweaters, inspects one of his plantings of an Alaskan lupine on a badly eroded area. Wildrye, a dune grass, was seeded in the background.

The desire and zest of the Icelanders to establish pleasant surroundings is reflected in the efforts of the citizens of the small island of Heimaey. In 1973, the inhabitants were forced to abandon their island because of a volcanic eruption that destroyed part of their village, Vestmannaeyjar, and threatened to block their harbor. The islanders returned, however, removed the debris, and repaired their village, then handshoveled cinders from the slope above the village so that the grass could grow again. As a teenage girl working on the project said, "We like our hills green" (2). The Vestmannaeyjar villagers planted 50 tons of grass seed in the vicinity of their village to do just that—make it green again.

Alaska—Iceland Exchanges

Iceland, with only about one-fourth of its 40,000 square miles vegetated, produces all of its meat and dairy products for over 200,000 people and exports a surplus. Some of our island and coastal regions have a potential for agricultural use similar to that which Iceland has sustained. We are attempting some farming in these areas, but on an incipient scale. Iceland has experienced centuries of intensive use, and has realized the consequences of misuse. Icelandic landholders, researchers, and administrators have gained knowledge from these experiences that is of considerable value to us. They also have plant materials of interest to us. Grasses from Iceland have shown more winterhardiness than many that have been tested from the Scandinavian countries. And these grasses have had a long history of grazing pressure that many of our grasses have not had. Their animals also are of interest because of their evolvement under a northern climatic regime.

Alternatively, the larger land mass of Alaska (586,400 square miles) with its richer flora represents a storehouse of potential plant materials for use in Iceland. This potential already has been demonstrated with applications in Iceland for Sitka spruce and some Alaskan willows and lupine, and the performance of some Alaskan grasses now being tested over there. Alaska's experiences coping with a more diverse and more severe environment also could be of value to the Icelanders.

Further, Iceland is part of a group of northern nations that have frequent exchanges regarding problems of the North. The excellent multi-linguistic ability of the Icelanders precludes language difficulties. Alaska obviously could benefit from closer associations with Iceland and its neighbors of the North.□

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ACKNOWLEDGMENTS

I am grateful to those who made this trip possible and to my very generous hosts in Iceland, particularly Thorsteinn Tomasson, Andres Arnalds, Sturla Fridricksson (all scientists at the Iceland Agricultural Research Institute) Bjorn Sigurbjornsson, scientist and Director of the Institute, and Sveinn Runolfsson, Director of the Iceland Soil Conservation Service.

Editor's Note: Since mid-September, 1977, the Alaska State Division of Agriculture, under the direction of K. Allan Linn, has been conducting cost-and-effect trials of land-clearing methods/technology as directed by the Commissioner of Natural Resources, Robert LaResche, and Governor Jay Hammond's Special Assistant for Agricultural Development, W. I. "Bob" Palmer.

Delta-Clearwater Lands Opened for Agricultural Use

2,000-Acre Clearing-Trials Project

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PROJECT INCEPTION

In 1976, an ad hoc committee on agriculture was formed at the request of Jay S. Hammond, Governor of Alaska. The specific objective of the committee was to investigate the feasibility of large-scale barley production in the Delta-Clearwater area of interior Alaska. The Delta-Clearwater area was selected as the site for the recommended 50,000-acre development-demonstration project because it included a large tract of latent agricultural land owned by the state, a road system, some private land currently used for agricultural production, and a small but growing agribusiness community (Figure 1). Additionally, the citizens of the area had included as a part of an area land-use plan a priority request for planned agricultural development (1).

As is the case for all lands used for agricultural production, development of project lands would involve clearing of the tree cover crop. The usual method of land clearing in Alaska is to form large berm piles, or rows, of trees and moss and clean the opened land of debris as much as possible before breaking (Figure 2). The berm piles are eliminated by several burnings.

Because land-clearing methods other than those currently used in interior Alaska were suggested and because there was a lack of knowledge about their applicability in the largely black spruce and moss cover on the development area, the ad hoc committee suggested that a 2,000-acre tract be set aside for clearing trials. A proposal was presented to the State of Alaska, Department of Natural Resources, by the USDA Soil Conservation Service to design, monitor, and evaluate alternative land-clearing methods (4).

The proposal included:

- Clearing which would knock down and windrow or pile standing vegetation and moss.

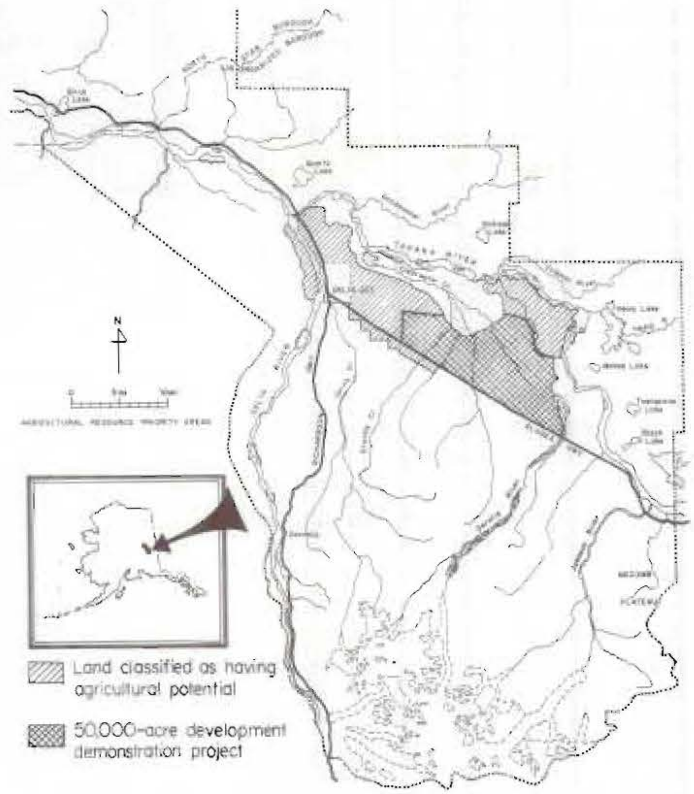

Figure 1: Delta-Clearwater Development Area.

- Burning the downed vegetation after it had dried sufficiently to permit complete combustion.
- Residue clean-up after the burn to ready the land for initial breaking.
- Breaking of the land to mix organic matter into the upper soil profile.

LAND-CLEARING TRIALS PROJECT SITE

Vegetative cover on the test site is native black spruce and hardwoods (aspen, poplar, willow, and birch) in the approximate ratio 9:1 by surface area. The average diameter of black spruce measured 12 inches above ground surface is 3¼ inches; hardwoods average 5½ inches. The density of black spruce larger than 1 inch in diameter exceeds 7,000 stems per acre (excluding the even-denser patches of stunted spruce), while hardwoods in scattered patches average approximately 5,500 per acre. A surface cover of moss, sedges, and shrubs, overlies the mineral soil by as much as 14 inches (extreme for Tanana series soils).

A plan for conducting initial clearing trials called for chaining the tree cover, using either V-blades or angled blades to windrow the ground cover material, and using piling blades to form loosely packed berm piles in preparation for removal by burning.

SEQUENCE OF OPERATIONS

To arrive at final ground conditions prior to removal of berms and/or knocked-down tree cover by burning or some other accepted method, twelve sequences of operations were performed (2). The operations involved in each of these sequences were chaining, shear and roll, standard berm, V-blade, raking/piling, and breaking with heavy off-set disk.

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Figure 2


Figure 3


Figure 4


Figure 5


Figure 6


Figure 7

Chaining Method

Two tractors, operating on traction trails, were used to draw the chain through the existing vegetation (Figure 3). This procedure oriented the woody vegetation in a uniform direction (Figure 4). Chaining operations tended to dislodge a significant number of the root crowns from the soil, especially when encountering timber 6 inches in diameter and larger (Figure 5). Trees that were not broken loose from the soil (usually less than 3 inches in diameter) would spring back to the upright position behind the chain. These trees that had not been tipped over usually sustained lateral root and branch damage.

One of the major problems encountered was the climbing of the chain up the trunks of the trees against which it was being pulled. Attaching a weight of sufficient size to the chain would have reduced this effect. An additional problem was that chaining had minimal impact on the existing moss cover, therefore soils will remain relatively wet becuase of slowly thawing permafrost.

Double chaining, or pulling the chain a second time in the opposite direction tended to greatly enhance the destruction of the woody vegetation. The attitude attained by the vegetation, following the first chaining procedure, tended to force the chain down nearer the ground where it was much more effective. Double chaining created a denser and more compact fuel load than did single chaining. However, subsequent tractor operations would be more hazardous due to the tangled tree mat.

Shear-and-Roll Method

Shearing and rolling the material into small windrows with the angled blade (Figure 6) was quite effective in areas of heavy moss. Downward pressure exerted on the blade held it on top of the mineral soil while peeling off only the organic mat (Figure 7). The soil was sufficiently frozen to avoid significant amounts of topsoil in the windrows.

The shear-and-roll technique is limited in dense timber due to the tangling of the vegetation. This tangled material will not roll but must be pushed into the windrow. Shearing also tends to cut some of the trees at the soil-moss interface leaving the roots firmly imbedded in the soil. Chaining before shearing helps to reduce this limitation.

Standard Method (Berm)

This method is essentially designed to concentrate the debris from a relatively large area into a compact berm. Clearing was accomplished on firmly frozen soil in order to avoid including excess topsoil in the berms. The vegetation was sheared with an angled blade and dozed into tightly packed, large berm rows by long pushes with a tractor. Most of the moss, organic matter, and snow was removed. Downward force was exerted on the blade in order to enhance its effectiveness in removing the moss. Approximately the same amount of root crowns remained in the soil with this technique as with the shear-and-roll technique. Again, prior chaining will reduce this problem.

V-Blade Method

Debris from V-blade clearing is deposited in small, loosely packed, ground-level windrows. The blade (Figure 8) was designed for maximum cutting, or shearing, of vegetation (Figure 9). It attained a faster rate of speed than did the other methods. Because of the large amount of horizontal surface on the blade itself and the tendency of the blade to float at the soil surface, only 50-70% of the moss layer was removed. The design of the V-blade could be modified to alleviate this problem somewhat.

When heavy wooded material was encountered, the blade tended to lift up and ride over some areas. The V-blade readily sheared off trees up to 8 inches in diameter, although most root crowns from V-bladed trees remained in the ground. Chaining prior to V-blading is advisable.

Figure 8

Figure 9

Figure 10

Raking/Piling

The raking/piling blade (Figure 10) was used to place previously severed material into large, loosely packed berm piles. Piling operations began during breakup after the snow had melted, thus reducing moisture in the berms. The soil was still frozen sufficiently to permit traction but thawed enough to allow removal of stumps, roots, and moss.

Heavy Offset Disk (Breaking)

Breaking operations were initiated in mid-June using a 13-foot, heavy offset disk with 30-inch disk blades pulled behind a Terex 82-30 tractor. The breaking trial was conducted following operations of the angled blade and piling blade. The disk was operated at a depth of approximately 10 inches and was quite effective in turning under moss and dislodging roots and stumps from the soil.

Table 1. Synopsis of Effectiveness of Several Land-Clearing Techniques used during Phase I, State of Alaska Agricultural Clearing Trials Project, 2,120-Acres—Delta-Clearwater.

	Clearing Method				
Clearing Effect	Chain	Floating V-blade (+ chain)	Shear and Roll (+ chain)	Standard Berm (+ chain)	Piling Blade, aft. chain
moss cover removed	0	50-70% (50-70%)	60-80% (60-80%)	90-100%	85-95%
root crowns >6" dislodged	60-80%	30-60% (65-85%)	40-70% (65-85%)	40-70% (65-85%)	95-100%
woody material severed	0-20%	100% (100%)	100% (100%)	100%	95-100%
snow in debris	none	minimal loose. pack.	minimal loose. pack.	tightly packed	none aft. breakup
tillable soil avail.	0	0	0	75-80%	75-85%
ant. drying rate: debris	moderate	rapid	rapid	slow	moderately slow
overall rate: soil thaw	slow	slow	slow	rapid	rapid
land condition after clearing	inaccessible to rubber-tired machines			litter soil, some anchored debris	
ant. burnability remain. debris	poor	good	good	poor	fair
topsoil in debris	minimal	minimal	minimal	minimal	minimal
major advantages	dislodges root crowns	speed, burnability	burnability	tillable land	speed, till. land
major disadvantages	moss, burnability	severed root crowns	severed root crowns	burnability, sev. root cr.	burnability

Note: All ratings are based arbitrarily on personal on-site observations without implementation of scientific sampling.

SYNOPSIS OF CLEARING METHODS AND RESULTS

Table 1 contains a comparative rating of the various clearing methods used during this trial project (5). Effects of these methods have been evaluated by observation only. Particular attention was given to the percentage of tillable soil available after each clearing method and the rapidity of drying of the debris, which was not burned.

As can be seen from Table 1, some methods left no area in a tillable condition. This does not imply that these clearing techniques will not be acceptable after burning. On the other hand, a high percentage of land left in a tillable condition does not imply that the land can be farmed in an efficient manner. As has been pointed out by the Soil Conservation Service, Anchorage:

> The proposed burning will be a vital phase of this project. The cleared areas will lend themselves to selecting nearly any size and shape of unit to be burned. . .The key to an efficient clearing operation in the Delta-Clearwater area will be the successful burning of sheared vegetation. . .The clean-up of debris following the broadcast burn is very important. Residue remaining on the fields will be directly related to the effectiveness of the shearing and burning operations. . .The amount and type of land breaking will depend on the success of the land-clearing methods and burn efficiencies. . .The trials will demonstrate whether breaking will need to be completed by heavy equipment as owned by contractors, or by farmer-operators that [sic] develop the land (3).

While final evaluation and judgment cannot be made until the land is in production, this information is useful in estimating the capabilities and limitations of the respective techniques used in the initial phase of land clearing.□

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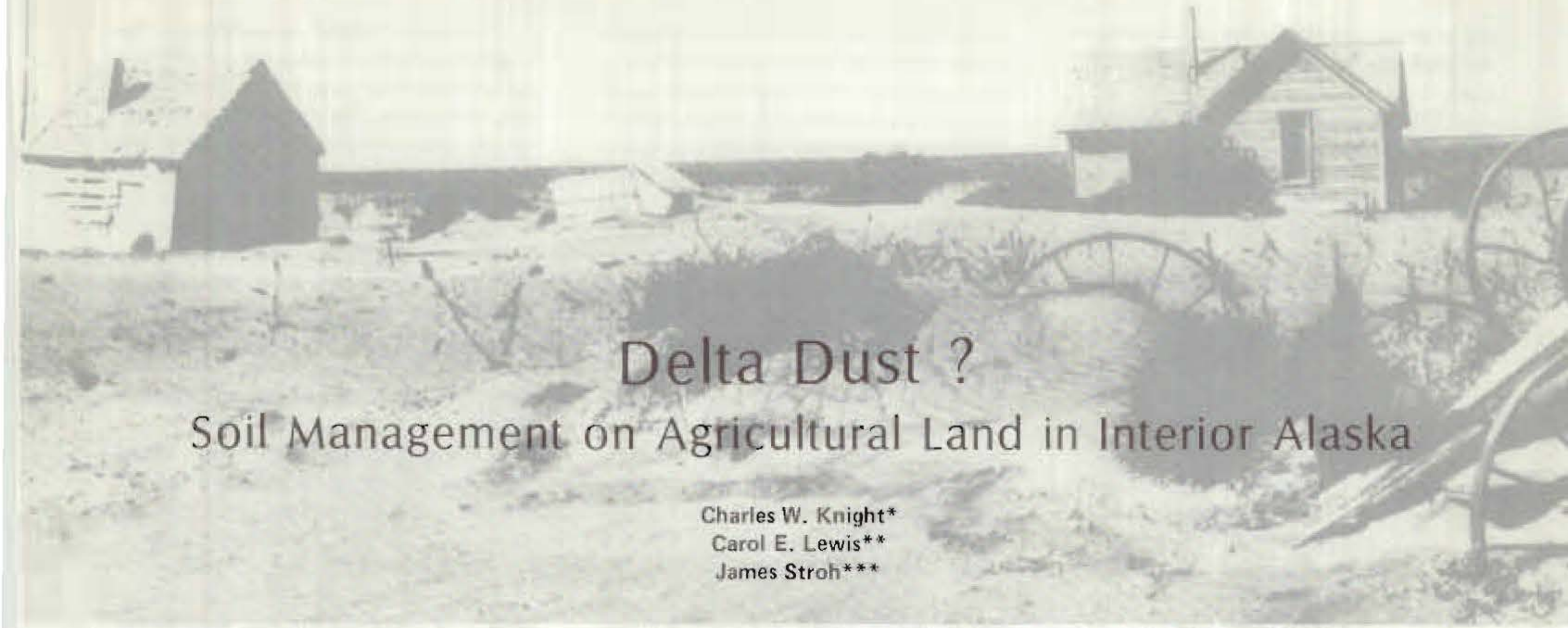
ACKNOWLEDGMENTS

All photos were supplied by Soil Conservation Service, U.S. Department of Agriculture, Delta Junction, Alaska.



Delta Dust ?

Soil Management on Agricultural Land in Interior Alaska

Charles W. Knight*
Carol E. Lewis**
James Stroh***

Soil erosion is a growing problem throughout the 50 states. According to one estimate, farmers presently till more than 250 billion tons of soil a year on approximately 370 million acres of cropland (2, 4). For more than four decades, soil conservationists have worked toward a goal of improved soil management through voluntary, cooperative programs with soil conservation districts and farmers. Yet, in 1977, 42 percent of United States' cropland had no conservation treatment (4). The subject of soil management is not thoroughly understood by landowners although soil is the common denominator of agricultural production and is a virtually nonrenewable resource.

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Alaska is no exception to other agricultural areas. The interior of the state, particularly the Delta-Clearwater area, can be compared to the northern plains states. In these states, small-grain crops are produced in a semiarid climate in which high-velocity winds occur in the spring, when the soil is most vulnerable to erosion, and during the winter, when it can remove the snow cover (6). In the Delta-Clearwater area, approximately 12,000 acres are now producing small grains, grasses, and rapeseed. By 1981, 60,000 acres of new land may also be in production. These lands may be subject to similar climatic conditions which have caused serious soil erosion problems in the northern plains.

The soils in the Delta-Clearwater area are predominately of the Nenana and Volkmar series. These soils are mostly silt-loam in texture, are shallow, and are slowly renewable (11). They are classified as being subject to moderate to severe wind erosion. Severe soil losses can occur if good soil management practices are not followed. Figure 1 illustrates a field in the Delta area which was disked and packed in the spring prior to seeding. The soil was left with insufficient roughness to break the scarifying effect of the wind. Figure 2, taken during the same wind storm, shows a nearby field with a relatively rough surface and a good trash cover with very little soil loss due to wind. Trash cover is only one method which can be used to control erosion. Conservation tillage research efforts have for several years given technical assistance to farmers to

Figure 1: The field in the background was disked and packed in the spring prior to seeding. That in the foreground had been disked leaving sufficient trash cover and surface roughness to resist erosion by wind.

Figure 2: The field shown had been chiseled in the fall leaving sufficient trash and large clods on the surface to inhibit wind erosion.

aid in erosion control. Various methods are available for different farming situations.

The USDA Science and Education Administration has for a number of years been conducting research into the causes and contributing factors of wind erosion on unprotected soils. The relationship between the annual soil loss by wind erosion from a given field and five major factors influencing wind erosion can be expressed as the empirical equation:

$$E = f(I, K, C, L, V)$$

where
- E = Average annual soil loss
- I = Soil erodibility index
- K = Soil-surface roughness
- C = Climate
- L = Field width
- V = Vegetative cover

This wind-erosion equation may be used to predict annual soil losses when all other factors can be determined.

Average annual soil loss, E, is expressed in tons per acre. The national maximum acceptable soil loss as set by the USDA Soil Conservation Service is based on the long-term maintenance of a fertile soil. The agricultural soils in the Delta-Clearwater area, being shallow and slowly renewable, have a low permissible loss. A tentative limit of two tons per acre annual loss has been set for them. Although two tons of soil may seem to be a great deal to allow, such loss would not even be visible as dust.

The soil erodibility index, I, is directly related to the percentage of dry-soil aggregates, or clods, greater than .03 inches in diameter. The greater the percentage of larger clods, the less erodible is the soil. Each soil has its own erodibility index. This index changes with the kind and number of tillage operations and the organic-matter content of the soil. Good management systems utilizing crop rotations and minimum tillage can improve the erodibility index. Original soil surveys in the Delta-Clearwater area indicated that most of the soils had a moderate erodibility index. Data collected in 1978 using a more precise measurement, however, show that the erodibility may be high. These studies are being continued to confirm the new findings.

Soil-surface roughness, K, is directly related to the most recent tillage operation. The height and spacing of the ridges left by the tillage or seeding implement are used to calculate this factor. For maximum effectiveness, the ridges should be oriented perpendicular to the direction of the wind. Effectiveness increases with ridge height up to four inches. Beyond that height, erosion increases due to wind turbulence caused by the ridge peaks themselves. Proper tillage implements and a minimum use of smooth packers can greatly reduce this wind-erosion factor.

Major climatic conditions, C, affecting wind erosion are windspeed and soil surface moisture. For example, the rate of erosion for a 30-mph wind is more than three times that for a 20-mph wind. Wind erosion decreases, however, as soil moisture increases. It is necessary to know the monthly average wind direction, speed, and total duration for a minimum of five years in order to calculate a good representative C factor for an area. The soil-surface moisture portion of the C factor varies directly with precipitation and is greatly affected by temperature. These conditions vary less than wind throughout the Delta-Clearwater area and long-term data on them are already available. A preliminary C factor for the area has been developed by the Science and Education Administration and this will be refined as more wind data becomes available.

The unsheltered field width, L, is measured along the direction of the prevailing erosive wind. Soil flow across an eroding field increases proportionately with distance downwind until, if the field is large enough, a maximum soil flow is reached. Field width can be controlled by management practices such as strip cropping, grass barriers, and tree shelterbelts or windbreaks. The width of a field protected by a windbreak is determined by both the height and density of the trees. Moderately dense windbreaks will protect a field width equal to 10-15 times the height of the trees in the windbreak. Very dense windbreaks create a turbulence on the leeward side which reduces the effectiveness of the wind-speed suppression. Less dense windbreaks reduce wind speeds the least, but allow better snow distribution across the field as they do not permit the snow to collect in drifts where the moisture from the melting snow does little good and can even curtail early spring work. Other management practices such as strip cropping that alternate tillage and vegetative cover in narrow strips perpendicular to the prevailing erosive winds will reduce the L factor. The optimum width of these strips is determined by the values of all the other factors in the equation and will vary as they change.

Erosion control provided by the vegetative cover, V, on a field is affected by the quantity, size, and orientation of the vegetation. The more cover, the better the protection it provides. Also, the finer the crop residue and the higher the residue stands, the more it slows the wind. Good vegetative cover is the most effective measure for controlling wind erosion and has the most influence in the erosion equation. Living or dead vegetative matter is effective. Vegetation also reduces total wind erosion by trapping soil particles blown in from adjacent unprotected areas.

The application of the wind-erosion equation should be a valuable tool in directing research efforts and assisting farmers in the Delta-Clearwater area in developing complete and effective management systems to curtail wind erosion. The relationships and magnitudes of the factors in the equation permit considerable latitude in determining what combination of crops, tillage, field width, and height and density of windbreaks a farmer should utilize in his particular operation. Development and refinement of factors I and C specifically for the Delta-Clearwater area are needed before the reliability of the equation is assured.

In an effort to refine these factors and to develop good soil management practices for interior Alaska, the Agricultural Experiment Station, the Soil Conservation Service, and the Alaska Department of Natural Resources, Division of Lands are cooperating in research efforts to quantify environmental variables and evaluate soil-management practices for the Delta-Clearwater area. Studies already in progress or planned for 1979 include: monitoring the physical and chemical properties of soils and water before and during crop production; recording weather data; and evaluating the effectiveness of various tillage implements and residue-management practices in controlling wind erosion.

The Agricultural Experiment Station and the Soil Conservation Service are presently cooperating in a study to determine the possible movement of fertilizers and pesticides through the newly cleared soils and the effect, if any, they may have on water quality (8). This study will also monitor soil moisture, temperature, depth to permafrost, and weather data within the newly cleared area. These data are relevant to fertilizer and pesticide transport through soils and will be extremely useful in making recommendations concerning soil-management practices.

The Division of Lands through the Geophysical Institute at the University of Alaska, Fairbanks, is studying winter and summer soil moisture losses on new and previously cropped lands (1). It will be possible to combine data from this study with those collected by the Institute of Water Resources, University of Alaska, Fairbanks, concerning the amount of moisture used by a barley crop from seed to harvest (7).

Other conservation work in the area, initiated by the Agricultural Experiment Station, includes a study evaluating the applicability of various tillage implements such as the plow, disk, chisel, and V-blade cultivator in controlling wind erosion and their effects on crop response. Some of these implements are also being used in a strip-cropping study started in 1978 in which alternate barley and fallow strips in 35-, 70-, 140-, and 280-foot widths were established. It is hoped that these strips will provide useful information on optimum strip-cropping widths for maximum wind-erosion control in the Delta area. Some recommendations have already been made concerning barley production in the Delta-Clearwater area which emphasize leaving standing stubble and crop residue on the soil surface during periods in which the crop itself affords no protection (5). Recommended methods include chisel plowing, stubble mulching, strip-cropping, and other recognized practices in the prevention of wind erosion.

In addition to these studies, the Division of Lands and the Geophysical Institute have been monitoring wind patterns in the Delta-Clearwater area for approximately one year (10). These data are being tabulated and correlated with data collected southeast of the 60,000-acre, new-land development from 1949 to 1969 by the U.S. Air Force (3). In this manner, it is anticipated that seasonal wind patterns for the entire Delta-Clearwater area can be established.

At present, no field research is being conducted concerning the scarifying soil surface winds which are related to erosion losses. Several soil samples from the Delta-Clearwater area have been sent to the Wind Erosion Laboratory in Manhattan, Kansas, to be used to collect preliminary information on their erodiblity (9). However, to date there is no satisfactory method of determining soil losses and associating them directly with the area wherein the scarifying winds are being measured.

Increasing world food demands will

Proper soil management in fields such as that shown above will ensure continued production from the fertile soils in the Delta area.

require development for agricultural production of new lands in Alaska, as well as other areas. This increasing food demand will require those lands already in production to be cultivated more intensively. Research efforts in Alaska must not only be expedited but expanded as well to meet the needs for a broader and continually advancing soil-conservation information base. The availability of research results specifically applicable to the Delta-Clearwater area will prevent interior Alaska from becoming a dust bowl like those of the 1930s in the Great Plains. Interior Alaska has the potential of becoming as valuable for crop production as the northern plains states. The information presented in this article will make agricultural production people as well as those having a general interest in the environment aware of the research being conducted; they may have an input as well.□

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'Summerred' Apple
A Delightful Addition to 'Chinese Golden Early' and 'Rescue' Eating Apples for Southcentral Alaska

Curtis H. Dearborn*

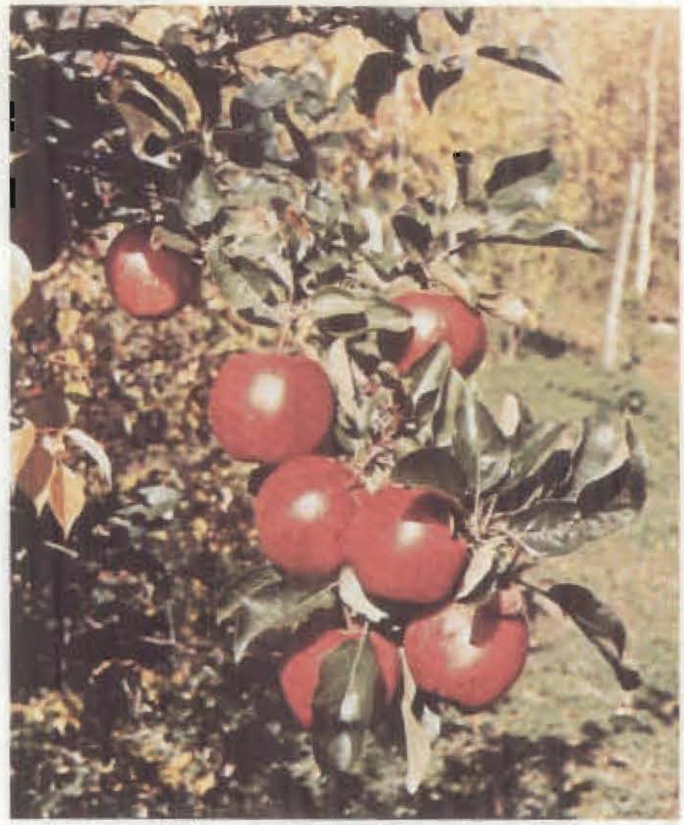
'Summerred' is the first apple of high eating quality ever to have developed ripe fruits on the tree in the Cook Inlet region of Alaska. Its flavor is a blend of 'McIntosh' and 'Delicious' and its fragrance exceeds that of 'McIntosh.' The texture of 'Summerred' resembles that of 'Golden Delicious,' except that 'Summerred' is firmer. 'Summerred' fruits were on display at the Alaska State Fair in Palmer from August 26 to September 5, 1977. Their bright-red color and large size attracted the attention of many fair goers (Figure 1). The purpose of this report is to acquaint prospective Alaskan fruit growers with the merits of 'Summerred' apple and how it may supplement earlier recommended apple varieties (1).

The 'Summerred' apple originated at Summerland, British Columbia, having been selected in 1961 by K. O. Lapins from seedlings of open-pollinated 'Summerland' S-4-8. 'Summerland' apple resulted from a cross of 'McIntosh' and 'Golden Delicious.'

During late winter of 1972-1973, scionwood of several apples was obtained from the USDA Plant Introduction Station at Glenn Dale, Maryland, and, in the spring of 1973, was grafted onto a five-year-old trunk of *Malus baccata*, a hardy ornamental apple first introduced to this region in early 1900. It was the only rootstock on hand at the time 'Summerred' scionwood was available for grafting. This scion produced the tree that first fruited in 1977. So far, winter injury has not been apparent on this tree of 'Summerred' even though it is growing without winter protection.

Summerred apple has been propagated on M 26 Dwarfing rootstock and standard seedling apple rootstocks by nurserymen in Washington and was listed for sale in 1978 by C & O Nursery, Buckley Nursery, and Van Well Nursery. Other suppliers may exist. There is no assurance that 'Summerred' will survive in Alaska on M 26 rootstock. However, these are common nonhardy rootstocks on which other varieties of apples and crabapples are sold to Alaskan growers.

Figure 1. Fruits of Summerred apple grown for the first time in Alaska in 1977. Their size can be estimated in relation to the 9-inch diameter plate.



A four-year-old 'Summerred' apple tree ripened 87 standard-sized apples in the Matanuska Valley in September 1977. They were beautiful, large, red, excellent eating-quality apples.

A short note released to the public in March of 1978 stimulated the operators of several plant outlets in the Cook Inlet region to obtain and sell trees of the 'Summerred' apple. From these local outlets and the out-of-state nurseries, customers have purchased trees and have planted them in a variety of locations. 'Summerred' apple, therefore, will be tested in a wide range of growing conditions in Alaska. In addition, ten cooperators at selected locations encompassing a wide range of environmental conditions from the Copper River Basin to Anvik on the Yukon River were each provided with a tree of 'Summerred' for evaluation.

Time will show whether the M 26 rootstock on which 'Summerred' was propagated has enough cold resistance to survive in Alaska. It is expected that some nurseries in Alaska soon will offer this and other desirable adapted varieties of apples on hardy rootstocks.

Related research in the Matanuska Valley was conducted in an effort to improve rootstocks. Seeds of *M. domestica*, the native apple of New England, from fruits of selected forest trees of New Hampshire, were planted in conjunction with seeds from 'McIntosh,' 'York Imperial,' 'Rescue,' 'Chinese Golden Early,' and 'Quality' crabapple. The 'Quality' crabapple was the only material that produced a significant percentage of winterhardy seedlings. Seedlings of *M. domestica* grew well in 1977 as shown in Figure 2, but their wood was not winterhardy, as can be seen in Figure 3. (Information gathered on these potential rootstock materials was obtained separate and distinct from the normal research program but is included here for guidance to others.)

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Figure 2. Seedling apple trees of M. domestica being grown for rootstock material. Some seedlings grew four feet tall.

The 'Summerred' that fruited for the first time in 1977 has set nearly as many fruit again in 1978, which is a very desirable fruiting characteristic. Some fruit trees do not fruit as heavily in the season following a large crop. Some apples do not set fruit with their own pollen. These points have not been tested in Alaska for 'Summerred' because nearby 'Chinese Golden Early' and 'Rescue' varieties were flowering when 'Summerred' was in bloom.

'Chinese Golden Early' is a very sweet, pleasantly flavored apple to eat out-of-hand. Its fruits are intermediate in size between those of 'Summerred' and 'Rescue.' It has been the earliest good-quality apple to mature on the tree. 'Chinese Golden Early' ripens at Palmer from August 18 to August 28 depending upon the season. Scionwood of this variety was obtained from the USDA Plant Introduction Station, Glenn Dale, Maryland, as PI 292930 and grafted to *Malus baccata* in 1967. 'Chinese Golden Early' fruited first in 1970 and in each year since. The ripening of this variety is always a pleasant beginning of the apple-ripening season in Alaska. Scionwood of this variety is available, in season, from the Alaska Agricultural Experiment Station, Palmer, Alaska. We have no information as to the availability of 'Chinese Golden Early' from commercial propagators.

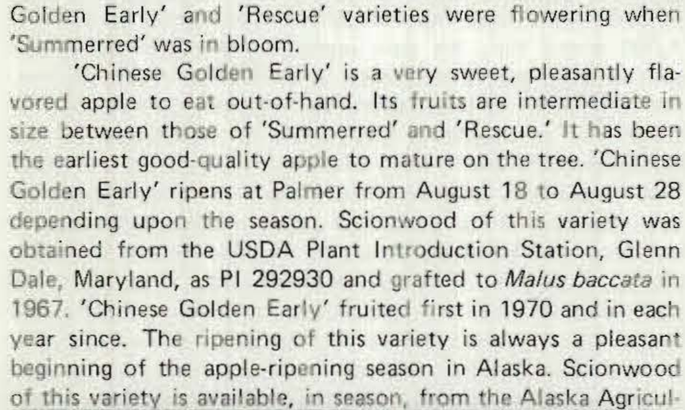

Figure 3. Dead seedling apple trees of M. domestica in the spring of 1978. Scarcely any survived the winter which was mild compared to most winters at Matanuska.

Figure 4. 'Rescue', and apple-crabapple cultivar that is winter-hardy, bearing heavily alternate years with some production in the off-season year. Although the fruits are small, their eating quality satisfies all children and most adults.

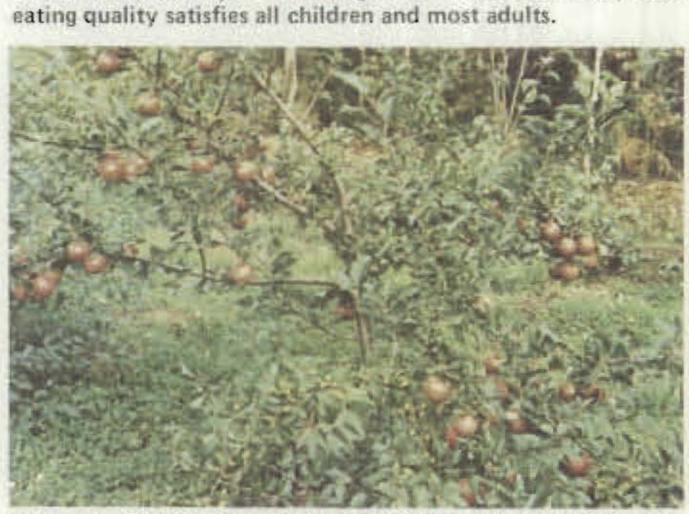

Figure 5. Distribution of 'Summerred' apples on a four-year-old top. The graft was made on a winterhardy rootstock.

'Rescue' is an apple-crabapple type, as shown in Figure 4. Its fruits are smaller than those of 'Summerred' (Figure 5). 'Rescue' usually is an annual bearer and has been bearing heavily at the Matanuska Station since 1955. Its fruits are nearly as large as 'Chinese Golden Early,' medium to dark red, sharp and spicy in flavor, and ripen on the tree about September 1. Scionwood of 'Rescue' is also available in season from the Experiment Station. We know of no other source of 'Rescue.' Neither 'Rescue' nor 'Chinese Golden Early' has shown evidence of significant winter injury. All three of these varieties were in the orchard during the -40°F temperature of January 4, 5, and 6, 1975.

Prospective Alaskan fruit growers looking for a better apple should find 'Summerred' an excellent choice as it adds a standard-sized, high-quality, storage-type apple to the very-desirable, early- and mid-season production of 'Chinese Golden Early' and 'Rescue.'□

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Asian Markets for Alaska's Agricultural Products

Wayne C. Thomas*

INTRODUCTION

In late October, 1977, a group of five people travelled from Anchorage to Tokyo to begin the Governor of Alaska's Agricultural Trade Mission to the Orient. It was thought by the group at the time to be Alaska's entrance into the world of international agricultural trade. Whether this will be realized or not, as we found out, not only depends on finding the markets but on producing the commodities at prices and qualities competitive with other exporting regions.

The group that boarded the airplane in Anchorage was somewhat diverse. It was led by W. I. Palmer from the Office of the Governor, and included Richard Eakins and Domonic Carney representing the Alaska Department of Commerce and Economic Development with specialties in project and market development; James Hutchinson, a private consultant whose expertise in international grain marketing provided the necessary contacts in the overseas markets; and, myself, with a specialty in agricultural marketing, whose role it was to serve as adviser to the group.

TOKYO

The first week of the trade mission was spent in Tokyo and included discussions with government and industry officials about the importation of barley and rapeseed into Japan. We learned that barley must be purchased through a Japanese trading firm by the Food Agency, Government of Japan, because some of the commodity is consumed directly, without processing, by the Japanese people. In meeting with Food Agency officials, we found them favorably disposed toward importation of Alaska barley and samples were requested.

Rapeseed, an oilseed crop, is not controlled by the Japanese government because the seed is processed into cooking oil, industrial oils, and meal for livestock. We discussed with the Japanese Oilseed Processors Association the possibilities of importing Alaska rapeseed into Japan and were advised that, if the crop were of comparable quality and price to Canadian rapeseed, it could be imported. Samples were requested by the Oilseed Processors Association

Meetings in Tokyo were also held with six major Japanese trading companies which purchase barley and rapeseed directly. All expressed interest in Alaska barley and rapeseed. We learned that barley shipments to Japan of 15,000 metric tons are common. The minimum shipment generally is 5,000 metric tons. For rapeseed, the standard tonnage is greater, 25,000 metric tons, but the minimum shipments are smaller, 1,000 metric tons. We were questioned about a deep-water-port loading facility in Alaska, as to whether it was ice free, and what kind of a transportation system would be used to move the commodities from point of production to the tidewater port. The trading firm kept returning to the point that quality and price must be competitive with Canada for both barley and rapeseed. The Alaska delegation's response was that the transportation and elevator system is in the planning stage and is scheduled to be ready when the Delta agricultural project is in production, and that we are aware that Alaska's export crops are in direct competition with those from Canada. One firm surprised our group by suggesting that, if some Alaskan farmers were interested in producing buckwheat, they would like to discuss marketing of this crop in Japan. We knew little about buckwheat and agreed to ask agronomy personnel at the Alaska Agricultural Experiment Station to grow a small amount during the 1978 crop year for laboratory testing in both Japan and Alaska.

SAPPORO

With our discussions in Tokyo completed, we flew north to Sapporo, capitol of Hokkaido. The airport of Sapporo is at Chitose which has been designated a sister city to Anchorage. We were greeted enthusiastically by the mayor of Chitose and found that we were official guests of the Prefectural Government of Hokkaido. The meetings became serious after the initial fanfare subsided. We met with representatives of the major agricultural industries of Hokkaido whose chief spokesman was Dr. T. Oohara, Director of the Dairy Research

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The first week of the Trade Mission was spent in bustling, downtown Tokyo above, discussing future trade relationships between Japan and Alaska.

The Japanese propensity for cleanliness and order in landscaping lends an air of beauty even to agricultural test plots, such as these in Hokkaido.

At an anticipated barley crop yield of one ton per acre, Alaskans must put into production many acres in order to send shipments such as this one at Inchon into Asian ports.

The Crown Colony of Hong Kong is one of the destinations in Asia for Alaska reindeer antlers, harvested annually, primarily on the Seward Peninsula.

Institute in Sapporo. Dr. Oohara apprised the Alaska Delegation of the importance of dairy-cattle production in Hokkaido. Barley and soybean meal are important ingredients in the rations of the 624,000 dairy cows in the prefecture, and, if the higher-protein barley grown in Alaska were substituted for other barleys, a reduction in the soybean-meal requirement appears possible. If so, this could provide a savings to Hokkaido dairymen, assuming the barley price were not too high. Dr. Oohara has since visited Alaska to reaffirm Hokkaido's interest in Alaska barley. Other crops were also discussed, including grass seed and seed potatoes, both of which can be produced in Alaska and may have the advantage of certain disease-free properties. It became apparent from our short Sapporo visit that significant marketing possibilities exist between Hokkaido and Alaska.

SEOUL

On November 5, the Alaska delegation flew to Seoul, Republic of Korea. Meetings were held the following week with government and industry people in Seoul and in the nearby port city of Inchon. We found that Korea imports substantial amounts of barley only in those years in which local production is inadequate. Barley is used only as a food grain in Korea and is not fed to livestock as Korean farmers appear to prefer yellow mixed feed whose color is provided by its major ingredient, U.S. corn.

One feed-processing company in Korea was sufficiently interested in considering the use of Alaskan barley in commercial livestock rations to request a sample for analysis. However, the position of the Korean government was that the only use for barley was as a food grain for human consumption and it has developed regulations preventing the importation of barley for animal feed. This works to Alaska's disadvantage, as our high-protein Alaskan barley is generally thought to be attractive for livestock rations. One possibility was mentioned during discussions in Seoul. Since barley is part of the diet provided Korean soldiers, the use of a high-protein product might increase the nutrition of the army personnel. Substantial market development efforts and even changes in Korean government policy are necessary to gain access to those markets in Korea which could use higher-protein Alaskan barley to advantage. This leads to the conclusion that Korea could not be anticipated to be a steady market for Alaska barley at this time. Regarding rapeseed, some local production occurs and virtually none is imported.

HONG KONG

We travelled to the Crown Colony of Hong Kong on November 10 to investigate a unique agricultural product which is presently being imported from Alaska. Alaska reindeer antlers are harvested annually (without killing the deer) by Eskimos, primarily from the Seward Peninsula, and are sold in Asian markets. Antlers are also imported into Hong Kong from Siberia, the People's Republic of China, and New Zealand. The antler is processed and sold as an oriental medicine. Little was known about the marketing process once the antlers leave Alaska, so the Hong Kong visit was made in an attempt to learn something about foreign markets for Alaska reindeer antlers.

A meeting was arranged to discuss reindeer marketing with a Chinese import-export firm. After walking through a myriad of back streets and small alleys which provided a closeup observation of how many Chinese live and work, we finally arrived at a rather nondescript building which housed the import-export firm. Once inside the offices, security appeared somewhat extensive. It was obvious we were going to have a meeting on a commodity that has substantial value. The meeting turned out to be informative and quite friendly. The firm's proprietor described how antler is graded, and what his customers look for in the product.

There are several types of antlers which are marketed as oriental medicines. These include antlers from spotted deer and red deer. Reindeer produce the least desirable type in the trade; however, markets still appear available for substantial quantities. The Russians and the Scandinavians do not market their reindeer antlers so Alaska is the only source. Antlers are processed then marketed primarily in Korea, Taiwan, and the People's Republic of China. There is limited information available as to who is the final consumer. It appears that this type of oriental medicine is used by older people in the countries mentioned. The buyer indicated that there appears to be some concern that the younger portion of the present population may break tradition and not develop consumption patterns associated with its use, the implication being that the market will diminish sometime in the future.

This can only be viewed as speculation because no demand analysis of which I am aware has ever been conducted on this commodity. The meeting ended with a request that a sample of Alaska reindeer antlers be forwarded to the firm. We agreed to make the Alaska Reindeer Herders Association aware of the meeting and the request.

TAIWAN

The final leg of the Alaska Trade Mission to the Orient was to Taipei, capitol of Taiwan, Republic of China. Meetings were held with representatives of government and industry, the most important of which was the Taiwan Barley Industry Association which we found to be interested in purchasing barley from Alaska. Their requirement was that the crop must be of competitive quality and price.

Barley in Taiwan is used both for human food and animal feed. The Taiwan Barley Industry Association expressed interest in hulless barley for human use, and, fortunately, appropriate varieties are being tested by the Alaska Agricultural Experiment Station. We also discussed their needs for large quantities of standard barley for animal feed. A buying agreement with the United States ties the price of barley to the price of United States corn and appears to discriminate against barley. There may be overriding provisions, but this cannot be determined without further study. In any case, the agreement comes up for revision in 1981 and Alaska's case can be made during the negotiating process. Representatives of the Taiwan Barley Industry Association have visited Alaska since our meeting in Taipei to reemphasize their interest in purchasing our barley. They also expressed interest in purchasing Alaskan rapeseed. This was somewhat surprising because we concluded while in Taiwan that there was very limited interest in rapeseed. Regarding the shipment of both rapeseed and barley, sizes of shipments appropriate for Japan also apply to Taiwan.

CONCLUDING REMARKS

The Alaska Delegation observed substantial interest on the part of prospective buyers as evidenced by requests for samples and visits to Alaska. Japan, particularly Hokkaido, and Taiwan appear to be potential major markets for Alaskan barley. Rapeseed is a major import commodity in Japan, and Alaskan rapeseed should be able to enter this market. Direct marketing of Alaska reindeer antlers to Hong Kong also appears feasible. There are several factors which will influence occurrence of all these events. Competitiveness in quality and price to alternative sources of supply is one major condition. A second is the allocation of a sufficient land base for farms in order to provide the minimum quantity to interest foreign buyers. For example, in order to provide 1,250 tons of rapeseed and 5,000 tons of barley for commercial shipment to Japan each year would require approximately 10,000 acres in production. This assumes an annual yield of rapeseed at .5 ton per acre and barley at 1 ton per acre in a crop rotation of rapeseed, barley, and fallow over a four-year period. The Delta agricultural project will provide enough land (60,000 acres) to meet the commercial tonnage requirements and more. However, if in-state needs increase, the only way in which crop export levels from Alaska can be maintained is to plan beyond the current Delta project.

Regarding reindeer, since most of the deer are herded on leased Federal land, any action by the Federal government to limit the use of aircraft in herding operations, especially in the proposed d(2) areas of the Seward Peninsula, will reduce the ability of the Eskimo herders to harvest reindeer antlers. Such restrictions could have a significant impact on future export markets and income streams of those herders.

To summarize, if Alaska agriculture is to have substantial growth, then markets must be found and maintained outside the state. Further, Alaskan farmers must be competitive and have available the land base required to provide significant quantities of agricultural products. If so, the markets are in Asia and are expanding.□

Editor's note: More detailed analyses of information gathered during the Trade Mission has been included in the following reports:

Carney, D., and W. Thomas. 1978. Alaska Grain and Oilseed Export Marketing, An Analysis and Suggested Approach., State of Alaska, Department of Commerce and Economic Development, Juneau.

Thomas W. 1978. Delta Agricultural Project: Observations on Markets, marketing and Agricultural Development in the Orient, Australia, and New Zealand. Agricultural Experiment Station, University of Alaska, Fairbanks (Xerox).

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Stern, R., E. Arobio, L. Naylor, and W. Thomas.1977. Socioeconomic Evaluation of Reindeer Herding on d(2) Lands in Northwestern Alaska. Report to U.S. Department of Interior, National Park Service, prepared by University of Alaska.

Woodland Nutrient Cycling
An Important Consideration in Renewable Resource Management

Keith Van Cleve*
Michael Weber**
Leslie A. Viereck***
C. T. Dyrness****

The distribution of soil-vegetation types along the Tanana River and in the Yukon-Tanana uplands of interior Alaska is strongly related to topography. The important components of topography include slope (with respect to horizontal), aspect (north, south, etc.), and position on slope. Forest productivity, as measured by tree growth and the accumulation of organic matter (biomass) in trees, shrubs, moss, and dead organic matter on top of the mineral soil (forest floor), is also related to these topographic features. Well-drained south aspects generally show the best soil development and support the most productive forests. Well-drained sites close to river channels also support productive forests, but here the alluvial soils are too young to display extensive development of the soil profile. Colder north, east, and west aspects and level topography may support low-productivity black spruce and paper birch forests. These sites may also be poorly drained and underlain by permafrost (See Figure 1).

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The more productive forest ecosystems tend to occur on warmer soils while the less productive ecosystems tend to occur on cold soils. Soil temperature appears to be related to moss production. Black spruce forests have a high level of moss production compared with other forest types. Furthermore, the depth of organic matter in the forest floor is greatest in those ecosystems which display the lowest tree production (Figure 1). During the same period of forest development, balsam poplar, paper birch, and white spruce may produce four to seven times more tree biomass above ground than black spruce (Figure 2).

Within a given forest type, how does the distribution of biomass and chemical elements and the annual cycle of these components differ between productive and nonproductive ecosystems? In 60 years, a paper birch forest may accumulate approximately four to five times the tree biomass (tops and roots) than may a black spruce forest in the same time period (Figures 3 and 4). Of this total, six times more biomass can be found in paper birch trunk wood. In contrast, 22 percent more organic matter may accumulate in the mineral soil and forest floor in black spruce forests compared with birch forests. The moss component of black spruce forests, which accounts for up to 6 percent of the accumulated net production, is not an important component of the more productive birch forests. On a unit-area basis, annual moss production in black spruce forests may be equal to or greater than tree production.

Following the trends in organic-matter production, more of the major important nutrient elements, such as nitrogen and phosphorus, are contained in tree biomass in birch than in black spruce. However, in both forest types, tree bole wood contains one-fourth or less of the total nutrient content of the tree. Removal from the forest of this portion of the tree for firewood, pulp, or lumber would result in a smaller drain on the fertility of the site than would whole-tree logging. Up to 42 percent of available phosphorus on the site may be removed in whole-tree logging. In land-clearing operations, removal of all plant material (including tree roots) down to the mineral-soil surface could result in the loss of 20 to 30 percent of the nitrogen and 70 to 90 percent of the phosphorus capital from black spruce and birch sites. The importance of this loss to the growth of the next generation of trees is difficult to assess and would depend on how rapidly nutrients are replenished from organic debris and mineral soil.

The rate of biomass and nutrient cycling is generally more rapid in productive birch than in black spruce. For example, the entire leaf crop of a birch forest is returned to the forest floor each fall where the nutrients are released for eventual reuse by the trees. Litterfall amounts to 51 percent of the aboveground annual production in a

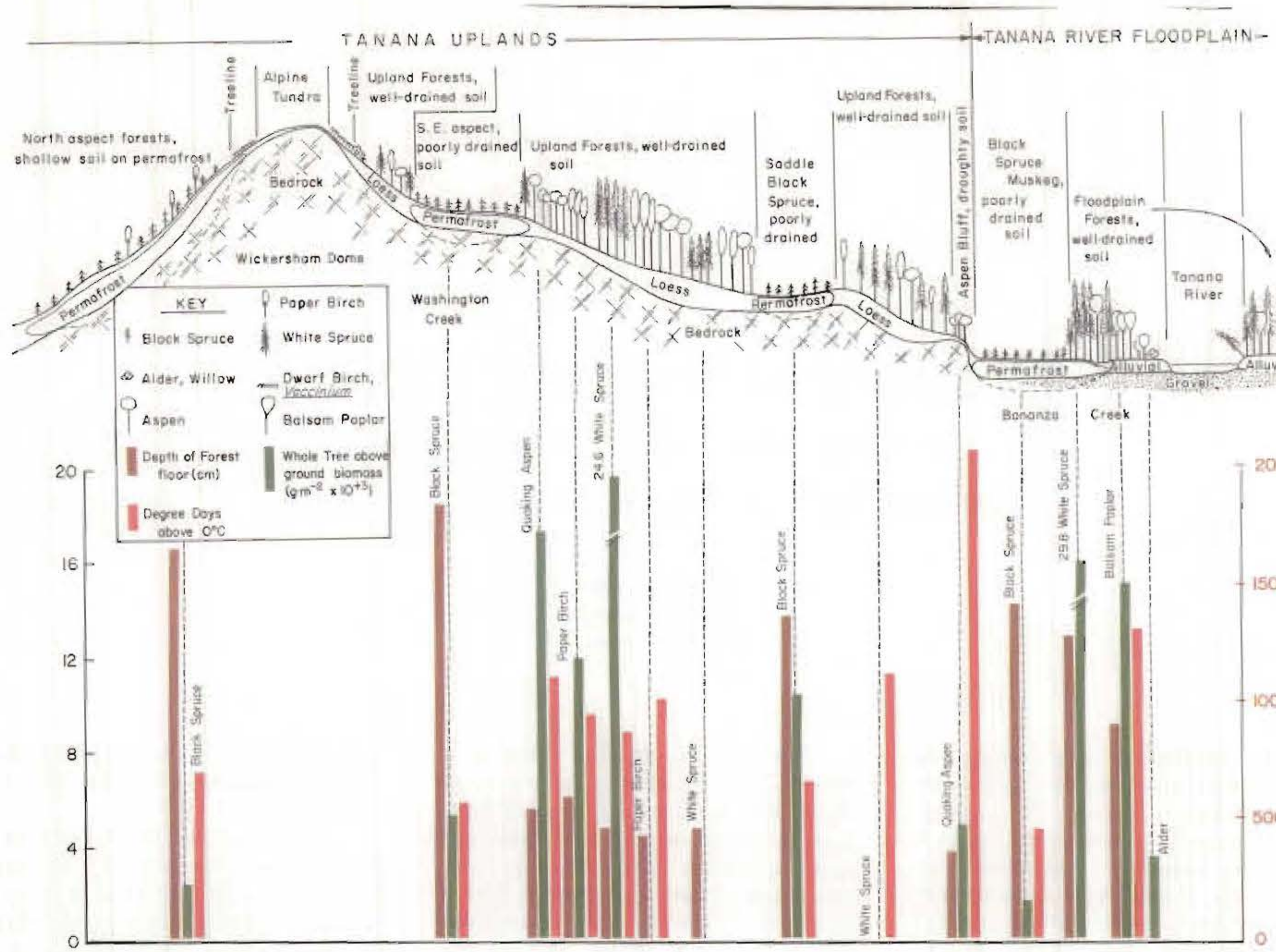


Figure 1: Composite cross-section showing distribution of forest vegetation types with topography in the Tanana uplands and lowlands in the vicinity of Fairbanks. Tree productivity, depth of forest floor, and soil temperature are presented for selected vegetation types.

60-year-old birch forest compared with only 32 percent in a 130-year-old black spruce forest (Figure 5 and 6). While birch replaces all of its leaves each year, new-leaf production in black spruce amounts to only 2 percent of the standing crop of leaves each year. The actual amount of litterfall is five times greater in birch and the amount of nitrogen returned to the forest floor in this material is also five times greater in birch than in black spruce. The rate at which the organic matter decomposes on the floor of a birch forest has been estimated at 6 percent per year compared with 2 percent annual decomposition in black spruce. This amounts to an annual release of 11 $g \cdot m^{-2}$ (110 $kg \cdot ha^{-1}$) nitrogen in the forest floor in birch compared with 0.4 $g \cdot m^{-2}$ (4 $kg \cdot ha^{-1}$) in black spruce. The net annual uptake of nitrogen by birch is about 63 $kg \cdot ha^{-1}$ and 17 $kg \cdot ha^{-1}$ in black spruce.

On the basis of the return of nitrogen in litterfall and precipitation and the release of nitrogen from the forest floor in the birch forest, potential supply is ahead of demand by the trees by a factor of about two to one. The amount of nitrogen removed in birch trunk wood after 60 years may be

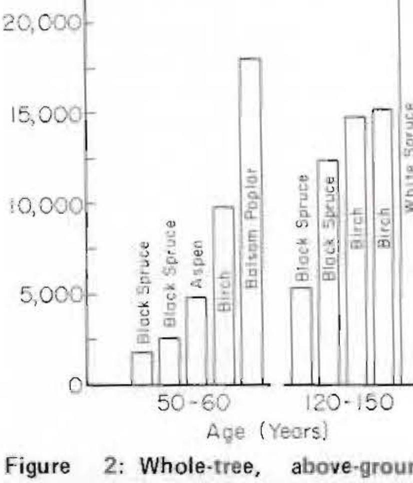


Figure 2: Whole-tree, above-ground biomass in selected taiga ecosystems near Fairbanks ($g \cdot m^{-2}$).

replaced from the forest floor reserves in less than two years. However, this wood removal does represent a net loss of nitrogen from the forest. Current estimates indicate this loss could be made up in about fourteen years through nitrogen fixation by alder, a component of many birch forests. In the black spruce, on the other hand, resupply of nitrogen is approximately half the current demand. This deficit might be replaced from nitrogen stored within the tree and reused in succeeding years.

If forest land is to be used for annual agricultural crop production, nutrient drain from clearing may be substantial with respect to initial crop growth and may require expenditure of considerable sums of money in order to build up the depleted nutrient capital. One clearing practice that would take advantage of nutrients stored in the forest floor, root systems, tree leaves, and branches involves broadcast burning (without piling) of the organic debris following clearing operations.

Based upon the phosphorus, potassium, calcium, and magnesium content of the forest floor (organic debris deposited on top of the mineral soil), the cash value of these nutrients in terms of fertilizer may range from $133 to $235 per acre. That is, removal of the forest floor during clearing operations might require this dollar investment in fertilizer in order to replace the lost nutrient capital and supply the nutrient requirements of an annual grain crop, according to Dr. Frank Wooding of the Agricultural Experiment Station. On the other hand, burning of this organic debris in place could result in release of most of these nutrients in the ash for subsequent incorporation into the mineral soil and use by plants. A substantial amount of nitrogen would be lost in burning of the organic matter. The portion of the nitrogen capital which would remain in the ash is unknown at this time.

Information on distribution and cycling of various nutrients is currently available for the major forest types in the Fairbanks area. This background information can be used to assess the impact of various management strategies on renewable-resource development.

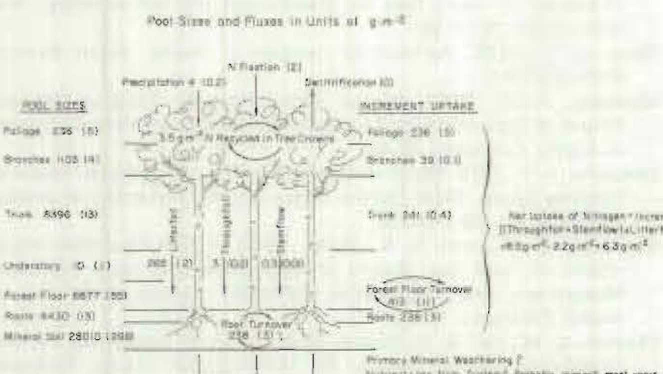
ACKNOWLEDGMENTS

Portions of this research were conducted in a cooperative study which included investigations from the University of Alaska and the Institute of Northern Forestry, U. S. Forest Service. Funding was obtained from the National Science Foundation, the McIntire-Stennis Cooperative Forestry Research Program, and the state of Alaska. Colored illustrations of tree species and associated soil profiles were painted by Patricia Davis, Research Technician, Forest Soils Laboratory, University of Alaska, Fairbanks.□

Figure 3

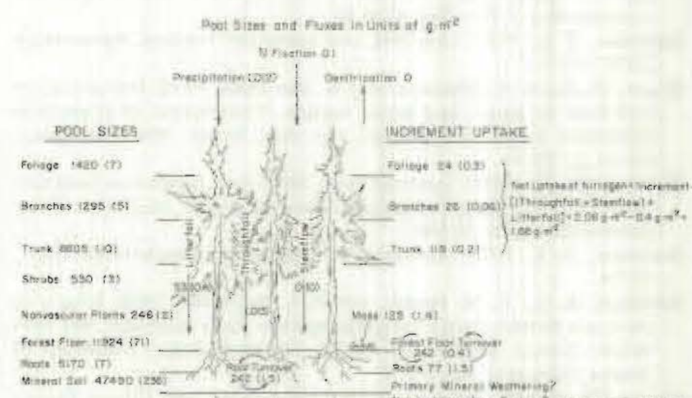
Figure 4

In 60 years, a paper birch forest may accumulate approximately four to five times more tree biomass than may a black spruce forest in the same time period.



*Nitrogen values shown in parentheses.

Figure 5: Cycle of organic matter and nitrogen* in 65-year-old paper birch ecosystem.



*Nitrogen values shown in parentheses.

Figure 6: Cycle of organic matter and nitrogen* in 130-year-old black spruce ecosystem.

In Memoriam

After nearly thirty years in Alaska Dr. Richard H. Washburn, research entomologist, died on January 5–just two months short of his sixtieth birthday. He was affiliated with Agricultural Research, Science and Education Administration, U.S. Department of Agriculture, in a cooperative program with the University of Alaska's Agricultural Experiment Station at Palmer. Dr. Washburn had been under treatment for a heart condition for some time. He leaves his wife, Mary Jane; his four children: Richard, Jr., Catherine Anne, Rebecca Mae, and Deborah Sue; as well as a host of friends and professional associates.

Dr. Washburn first came to Alaska with the U.S. Army in 1941, one year after his graduation from Michigan State College where he had majored in chemistry. After World War II, he began graduate studies at Cornell University and, in 1948, earned the Ph.D. degree, having majored in economic entomology. After a year's teaching assignment at the University of Georgia, he returned to Alaska to take charge of insect and rodent control for the U.S. Army.

In 1950, Dr. Washburn joined the Alaska Agricultural Experiment Station at Palmer, where he remained until his death. During his years at the station, he was involved in a number of important programs. Warble infestation in reindeer has long been of serious concern to Alaska's Eskimo reindeer herders and Dr. Washburn sought to find a solution to that problem, with some success. Root maggots can always be counted on to invade any garden in Alaska, and Dr. Washburn directed considerable amounts of research at ridding Alaskan gardens of this ubiquitous pest. Other work conducted in his diversified research programs included an effort to control the deposition of blowfly eggs on drying fish, and studies aimed at checking the damage inflicted on many plants by the cutworm, the larva of the moths of the family, *Noctuidae*.

Many of his research projects demonstrated Dr. Washburn's enthusiastic interest in plants, an interest which extended into his family life. He and his wife for several years have owned and operated a commercial nursery near Palmer. The reliability which could be expected from his plants gave the nursery a respected reputation.

The late Dr. Richard H. Washburn.

Dr. Washburn was a professional researcher, and, in this role, he enhanced greatly the body of scientific knowledge which has encouraged agricultural progress in Alaska. Professionally and personally, he will be missed. □

Publications List for 1978

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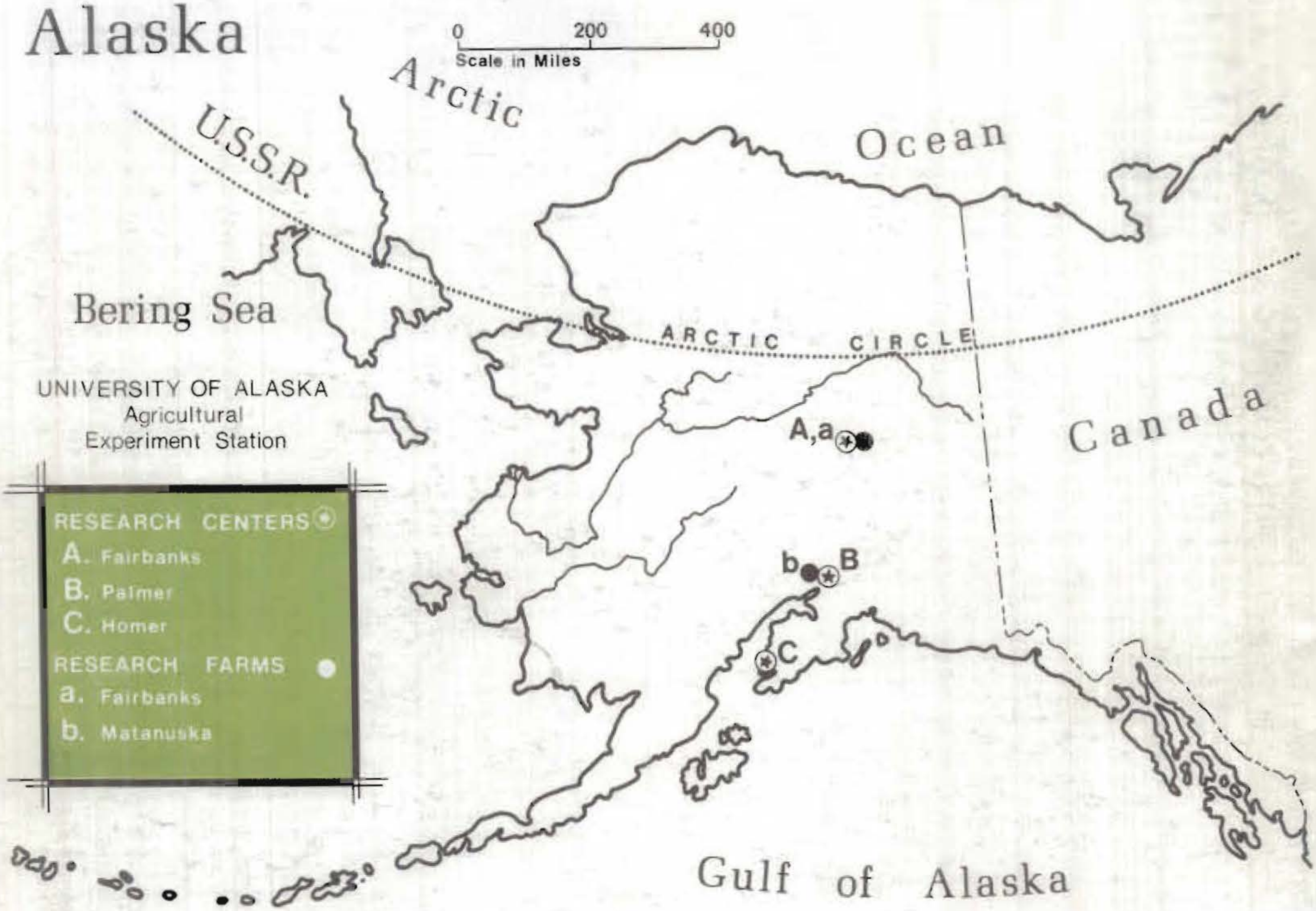

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