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Horticultural Limitations and Potentials of Alaska's Arctic, Particularly the Kobuk River Region

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ABSTRACT. Horticultural background of Alaskan Eskimos is very limited as they have not traditionally cultured plant material. A decline in fish and game and increasing costs of foods shipped via air from other states to the Arctic has been taken as a challenge to grow crops to supplement their diet. Analysis of very limited climatic data indicates that growing conditions are adequate for potato production in some areas and suitable for the production of numerous other crops. The potential for producing potatoes to supply all of the food energy for the people of Alaska's Arctic seems real. Insulated storages will be necessary to hold the crop and seed supply throughout the year.

Preparation of land in the Arctic for planting has been done by hand labor until very recently. Newer cultural practices, together with plastic covered family-size greenhouses, have been used to grow tomato, summer squash, cucumber and bean to market maturity.

Varieties of vegetables adapted to other regions of Alaska have been observed in the Arctic for two seasons and are documented in colored photographs. Most varieties were found to be very productive of high quality produce in gardens of villages of Kiana, Ambler, Shungnak, Kobuk and Noatak.

RÉSUMÉ. Le connaissances horticoles des Esquimeaux d'Alaska sont très limitées car de tout temps, ils n'ont pas cultivé de plantes. Il y a eu une baisse de la pêche et de la chasse et le coût des marchandises, importées par avion d'autres états vers l'arctique, s'accroit; aussi c'était un defi à relever que de cultiver et recolter pour completer leur regime alimentaire. L'analyse des données climatiques très limitées, indique que les conditions de croissance sont adéquates pour la pomme de terre dans quelques regions et acceptables pour la production de bien d'autres recoltes. Le potentiel de production des pommes de terre semble reel, il devrait être suffisant pour subvenir à l'alimentation des gens de l'Arctique Alaskien. Des silos protegés seront necessaires à la conservation de la récolte et à l'approvisionnement en semance pendant toute l'année.

Jusqu'a très recémment, la préparation du sol de plantation en Arctique, se faisait "à la main." Maintenant, il y a des practiques plus modernes de culture: des serres, de taille familiale, recouvertes de plastiques, s'utilisent pour faire pousser des tomates, des courges d'éte, des concombres et haricots à commercialiser à leur maturité.

Des variétes de légumes, adaptées à d'autres regions de l'Alaska, s'observent dans l'Arctique depuis deux saisons; des photographies en couleur en font foi. La productivité et la qualité des produits sont excellentes pour la plupart des varitiés, dans les potagers de villages de KIANA, AMBLER, SHUNGNAK, KOBUR et NOATAK.

GARDENING HISTORY

Vegetable growing in the Arctic, north of the 66th parallel, is not new as there are many reports dealing with vegetable growing in northern Scandanavia and Russia. However, not many persons in Alaska's Arctic have grown horticultural crops. Even fewer have a background in gardening under Arctic conditions.

Early missionaries, teachers, traders and miners brought some knowledge of gardening to the Arctic region and grew numerous kinds of vegetables to

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supplement their fish and wild-game diets. While those "outsiders" remained with the indigenous people, a few natives planted small gardens but the teachings of the "outsiders" practically disappeared when they died or moved on to other villages.

There are no records or folklore to indicate that Alaskan Eskimos have traditionally cultured any plant material. Introducing the culture and use of vegetables into their lifestyle necessitates a change in their philosophy from an almost total consumptive to a productive attitude. Such changes cannot be expected to occur rapidly. Those who will accept the challenge and provide the guidance in choosing tillable land, selecting machinery, fertilizer, seeds, irrigation equipment and storage facilities must also communicate cultural practices over a considerable period of time as was done for nearly a half century as people moved westward across the United States. However, this does not mean that some individuals cannot and will not be successful growers soon.

It has been written that agriculture is unnecessary in Alaska, Vanderhill (1973). Such a statement can have considerable negative influence on people who neither comprehend the meaning of agriculture nor the vastness of Alaska's land mass. What such a writer fails to understand is that people who produce food have the privilege of storing some. Most of Alaska's population is 1500 to 3000 air miles from its primary food source and is usually without sufficient reserves to feed itself for a 6-week period. Presently the U.S. Congress is debating the d-2 Land Proposal which is a part of the Native Land Claims Settlement Act affecting uses that can be made of large areas of land in Alaska. Possibly the great wilderness that would be created by passage of such a land use bill would be a first step toward making sure that Alaskans remain dependent on outsiders for their food, clothing and shelter. Certainly legislation setting aside lands for agricultural usage should precede any considerations for park land and wilderness until Alaska's food requirements of the crops that can be grown in Alaska are assured. For example, Alaska could be producing, in addition to its own requirements, all of the cabbage that the conterminous United States uses in the form of sauerkraut if the river bottom lands remain available for cropping rather than Game Refuges and Scenic River withdrawals. Some might believe that the conveyance of large tracts of land to the Eskimos through the Native Land Claims Settlement Act will provide them with a base on which they can soon grow horticultural crops successfully. Except for a very few individuals, any form of cropping the land is a new venture for them.

Encouragement and financial support for gardening in this northern region became a reality in the late 1950's when Col. Marvin R. Marston, known throughout northwestern Alaska as "Muktuk", encouraged the legislature to grant a homestead at Unalakleet (Fig. 1) to the late Senator Beltz. "Muktuk" became well acquainted with the Eskimos of Alaska through his assignment to organize them in defense of their region when it became apparent in the early days of World War II that the Japanese might attempt to occupy Alaska.

In his book *Men of the Tundra* (Marston, 1969), "Muktuk" retells gardening experiences of Eskimos that began with the efforts of missionaries in Alaska in the late 1800's. During his travels among the Eskimos he observed soil and

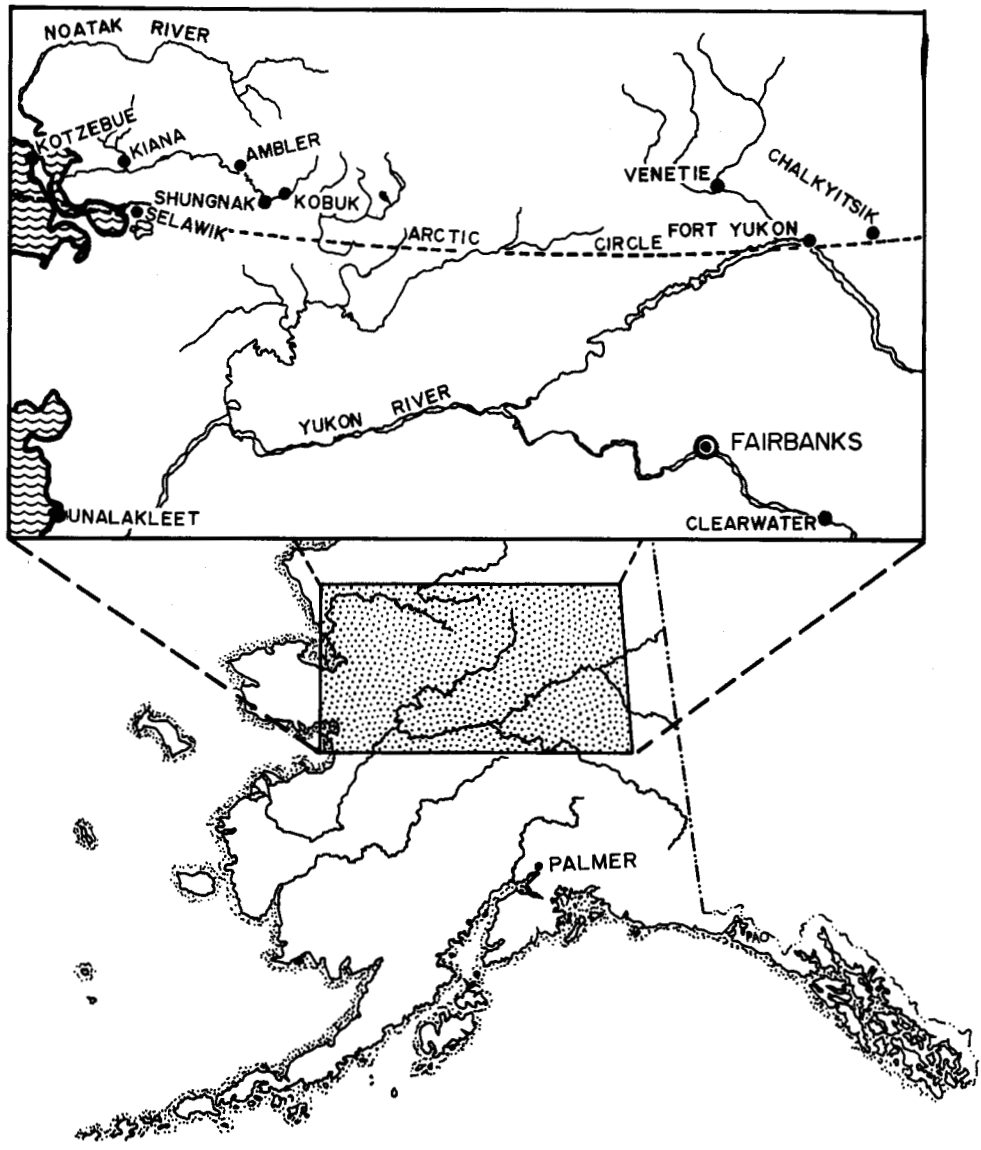

FIG. 1. Enlarged portion, 64° to 68° North latitude, of the Map of Alaska showing the location of villages on the river bottom-lands of the Arctic where numerous horticultural crops have been grown successfully.

climatic conditions at Unalakleet and along the Kobuk River that convinced him that these people should be growing vegetables for their families and possibly for people in villages where the environment was less favorable for gardening. He foresaw the difficulties of soil preparation without power tools and the expense involved in procuring and shipping land-clearing equipment to villages whose principle means of supply was the airplane. In 1959, "Muktuk" requested that I visit the people of Unalakleet, (63° 53′ N.) and provide some guidelines for

expansion of vegetable growing. I toured their gardens with him and saw mature plants of cabbage, potato, turnip, carrot, and numerous other kinds of cool-season crops. Heavy equipment suitable for land clearing was in Unalakleet in 1959 under the control of federal agencies but unavailable for clearing land for food production. Clearing by hand began in 1960 on the North Fork of the Unalakleet River and food production soon reached commercial proportions. In some seasons potatoes have been shipped to Nome and other communities of the region, attesting to the fact that adapted varieties of some crops would grow to market maturity if cultural practices already in use in Alaska were applied.

INFLUENTIAL PEOPLE

Although numerous agencies have made efforts in the direction of encouraging vegetable production in remote and Arctic areas of Alaska, persons with the know-how in vegetable crops production have not remained a sufficient number of years in villages to establish the art of vegetable growing. Agency-supported persons who have visited and given guidance to these northern people include the late Herman Turner, Extension Agent-at-Large, University of Alaska, Fairbanks from 1956 to 1961; Harold Pillsbury, Extension Horticulturist, University of Alaska, Fairbanks, 1957 to 1965, and Virgil Severns, Agricultural Agent, University of Alaska, 1961 to date. Others who have remained in a village for a few months to several years are: Max Cole, Steve and Orie Haas, Dave Hassinger and presently Lowell Lambert at Aniak. Dick Birchell contributed to the gardening experiences of the people of Venetie while there as a teacher with the Bureau of Indian Affiars. During his stay at Venetie I saw an an excellent

FIG. 2. Potato varity trial in David Salom's garden at Venetie in 1963 showing differences in adaptation but good production. Dick Birchell, center, visits with Virgil Severns.

crop of Ontario potatoes grown in a village garden beside the Chandalar River. A portion of this crop was taken upriver to Arctic Village and traded for caribou in a year when the animals did not migrate through the Venetie area. Potato variety trials at Venetie, Fort Yukon and Chalkyitsik, all above the Arctic Circle, demonstrated without question that locally grown potatoes could be the principle starchy food for people of the Arctic (Dearborn, 1974). A potato trial at Venetie is shown in Figure 2. At Unalakleet, Kenneth Anderson (pers. comm) and several predecessors associated with the Covenant High School since the early 1950's have succeeded in attaining production of vegetables on a commercial scale. Gardening activities at Aniak since the early 1960's, although not in the Arctic, have remoteness problems that recently have been evaluated in economic terms (Lewis *et al.*, 1978). Dr. Gladys R. Tinney, Program Manager for the State Department of Education, Division of Educational Program Support, 1975-77, brought instruction in vocational agriculture to numerous remote villages, a much needed service for all Alaskan youth. Recently Tony Schuerch, with Kobuk Valley Educational Services, Kotzebue, has guided the use of funds provided by the Marston Foundation during 1977 and 1978. In addition he has solicited assistance in choosing machinery, hand tools, fertilizers, seeds and pesticides for 250 family gardens in the Kotzebue region. Funds for fencing were obtained in 1978 by Mr. Schuerch through a Grant from Brigham Young University.

WHY ARCTIC GARDENING NOW?

One of the interesting things about horticultural crop production in Alaska is the background of the people who have been or who may be involved. As I review what people have written and match their thoughts with my experiences, I find that people on the land, with few exceptions, have not come from families whose livelihood came from growing row crops: vegetables, fruits, trees or ornamentals. I also find, as others have, that Eskimos have existed in the Arctic region until recently without access to the major energy foods used by other peoples of the earth. Why then should there be concern at this time for helping persons in the Arctic to produce row crops? The most humane reason for helping Alaskan Eskimos to grow food is their need for it and their lack of income to pay prices asked for perishable foods grown in other states and shipped 3000 to 5000 miles via air to the Arctic region.

The era of electricity has now reached the Kobuk Region so that foods can be stored frozen. Electricity is oil-generated and very expensive; even so, food items of potato, pea, carrot, beet, summer and winter squash, broccoli, cabbage, cauliflower and rutabaga produced locally and frozen could be more economical than commercial frozen foods from West Coast suppliers. Electricity from wind power is already being used by one family in the Ambler area and it seems reasonable to believe that far greater use will be made of wind-driven electrical generators.

Another good reason for local production is that vegetables and fruits adapted to the region would be available in the villages if shipping lanes to or within Alaska were closed or crop failures in other regions resulted in short supplies.

Furthermore, the quality of vegetables and fruits is unsurpassed when grown under the long daylight hours of summer and cool climate of the Arctic.

CLIMATE AND PLANT RESPONSES

The temperature of the 4-month vegetable growing season of this northern region as recorded by Official Weather Observers at Shungnak 66° 53′ N. Lat. from 1945 through 1950 and the 5-month period for Kobuk 66° 54′ N. Lat. since 1964 reveal some interesting facts. At Shungnak (Climatological Data Alaska Section, 1945-1950) temperature records for the first 10 days of June for the 6 years showed 34 of the 60 nights as having temperatures under 42° F. Four of these cold nights ranged from 30 to 28°F. This is not quite as bad as it appears to be because these low temperatures last only several hours. Night temperatures in June of 1945 were especially cold and this should not be ignored in planning for the future. The average monthly maximum and minimum temperatures for May, June, July, August and September are summarized for Kobuk, Fairbanks WSFO AP and Clearwater, Alaska for the years 1964 through 1977 (Climatological Data, Alaska Section, 1964-1977). To illustrate more vividly how Alaska's high latitude climate differs from that in lower latitudes, data from the Richland, Washington station, 46° 34′ N. Lat. are included in Table 1.

TABLE 1. Average maximum and minimum temperatures °F for months of May, June, July, August and September at three high latitude regions of Alaska and, for comparison, a mid-latitude station.

N. Latitude Location	66° 54' Kobuk		64° 49' Fairbanks WSFO AP		64° 03: Clearwater		46° 34' Richland, Wash.	
Month	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
May	49.3	27.3	58.0	37.4	58.6	29.5	75.5	47.3
June	66.5	42.0	70.8	50.2	69.9	39.7	84.9	59.4
July	69.4	45.5	72.3	52.5	72.5	42.9	90.2	58.9
August	64.3	42.9	66.6	47.2	66.5	38.1	88.9	57.9
September	51.7	32.1	55.4	36.3	55.4	28.1	80.0	51.0

The two degrees of higher latitude at Kobuk are reflected in slower warm-up in May, particularly the lower mean night temperature. For the remainder of the growing season, nights at Kobuk were warmer than those at Clearwater. September cooling rate at Kobuk appears to have been slower than that at Clearwater. The extent of frosting rather than average temperatures determines whether or not some crops can be grown without protection (Table 2). Frosting of warm-season crops can occur in any month in the general area of these climate stations even though frosting did not occur in July at Fairbanks WSFO AP. The lack of an adequate network of weather-recording stations to measure Alaska's climate in detail accounts for no measured frosting in the Fairbanks area during this period and the futility of trying to state length of frost-free growing seasons by villages. At Kobuk, temperature recordings since 1964 show that temperatures in July and August occasionally reached the high 80's and 90°F in some years. Persons unfamiliar

TABLE 2. Number of nights when air temperature below 32°F were recorded during July and August for the years 1965 through 1977.

	Locations		
Month	Kobuk	Fairbanks WSFO AP	Clearwater
July	8	0	7
August	41	16	55

with the climate of this Arctic region might presume that these temperatures would be detrimental to plant growth. They would be if they persisted but even in the land of the midnight sun, high night temperatures are accompanied by adequate light intensities to sustain photosynthesis. Consequently, the plant is continually adding to its mass, whereas at high night temperatures in lower latitudes, the same crop plant would be in darkness and losing more energy through respiration because of the long night.

Hours of possible sunlight (Scientific Services Office, 1965) in the Arctic Region compared with a 46° latitude region are shown in Table 3. Although crops are not planted in the open until about June 1, this light record includes May because greenhouses in the Arctic would be in operation this early. September has been omitted because early field frosting destroys frost-sensitive crops. Assuming that crops have emerged in the Arctic by June 5 when continuous sunlight is possible (column 3 of Table 3) they would be exposed to 1848 hours and 37 minutes of daylight during the 87 day period June 5 through August 29. This is the same number of hours of light to which plants would be exposed at the 46° latitude in 123 instead of 87 days.

TABLE 3. Possible hours and minutes of sunlight for the period May 1 - August 29 for two widely separated latitudes with summations for 123 days.

		N. Latitude 66° 54' Location Kobuk				N. Latitude 46° 34' Location Richland, Wash.			
		Sunlight	Duration	Accumulated		Sunlight	Duration	Accumulated	
Month	Day	Hr.	Min.	Hr.	Min.	Hr.	Min.	Hr.	Min.
May	1	17	39			14	21		
May	31	22	41	699	15	15	28	523	15
June	5	24	00	891	15	15	35	601	10
June	30	24	00	1419	15	15	43	994	15
July	5	24	00	1539	15	15	38	1072	25
July	30	19	22	2069	55	14	52	1453	05
Aug.	4	18	39	2163	10	14	40	1526	25
Aug.	29	15	19	2547	52	13	29	1848	42

Average daily light values recorded with pyrheliometer (Climatological Data, 1972) at Fairbanks WSFO AP, which is 1° 51' below the Arctic Circle, approximate 57145 Langleys (A Langley is the unit used to denote one gram calorie of energy per square centimeter received on a horizontal surface.) for May, June, July and August of 1972. Measurements taken similarly at Richland, Washington show 75607 Langleys for the same period. As long as the heat lost during the growing season does not result in frosting in July and early August the northern climate reduces respiration and this, coupled with

the long light period, allows for rapid growth and development of tubers, roots, seeds and leafy storage organs depending upon the variety and nature of the species.

SOIL AND WATER

Soils in the Kobuk region suitable for vegetable growing are located mostly along the river banks and flood plains. They are find sands supporting horsetail, sedges, alder, cottonwood, birch, poplar, spruce and willow. Areas above the flood plain are covered by tundra and thaw very little under this insulating blanket. Dry lake beds are potential tillable areas. The few soils that have been tested for acidity have shown readings of pH 5.6 at the 3-inch depth and pH 5.3 at the 6-inch level for virgin soils. Garden soils in use on old campsites show the effects of wood ashes of camp fires. Soil reaction in these and in dog yards is near neutral, pH 6.8 and 6.9. Willow leaves on plants at Ambler showed chlorosis resembling manganese deficiency symptoms.

River water is ample to supply irrigation needs of the foreseeable future. Presently permafrost is near the surface of tundra-covered soils but it may melt down after removal of the tundra so that the land can be tilled. Irrigation will be needed in most places for satisfactory crop growth. Shallow ponds further back from the river banks may be a source of irrigation water. Already, villagers have demonstrated that the soil along the river banks will support good growth of vegetables when fertilized with an 8-32-16 commercial fertilizer.

GARDENING ALONG THE KOBUK

Further stimulus for developing the horticultural potential of the Arctic has been given by the Marston Foundation of Anchorage.

In 1977, again at the request of Col. Marston, I visited Ambler on the Kobuk River and saw a few well weeded and watered gardens producing good vegetables (Dearborn and Vandre, 1979).

Isaac Douglas's garden, well above the high water line of the Kobuk River, two miles above Ambler contained lettuce, Swiss chard, beets, carrots, radishes, turnips, kale, peas and potatoes (Fig. 3). Each of these vegetables had made good growth. Radish, lettuce, turnip, Swiss chard and beets were being used. An excellent pea crop was ready for picking but non had been picked because it was a new kind of plant and its maturity was not understood (Fig. 4). Potatoes had developed tubers over 2 inches in diameter. Rabbits and mice had found the quality of the vegetables to be excellent and had eaten most of the chard, beet tops and carrots, as shown by the remaining chard stubs (Fig. 5). An on-the-spot test of the soil showed a reading of pH 6.8 to 7.0. This would account for a few scab pustules that were observed on several potato tubers. Mr. Douglas chose the garden area knowing that it had been an old campsite of earlier years. Thus, I would expect the lime in the ashes of the campfires to have raised the pH above that of other gardens that showed readings of pH 5.7 to 5.9.

FIG. 3. Isaac Douglas in a portion of his garden at Ambler visiting with Doris Dearborn and Kristie Long as they pick peas and discuss shelling the pods and culinary preparation.

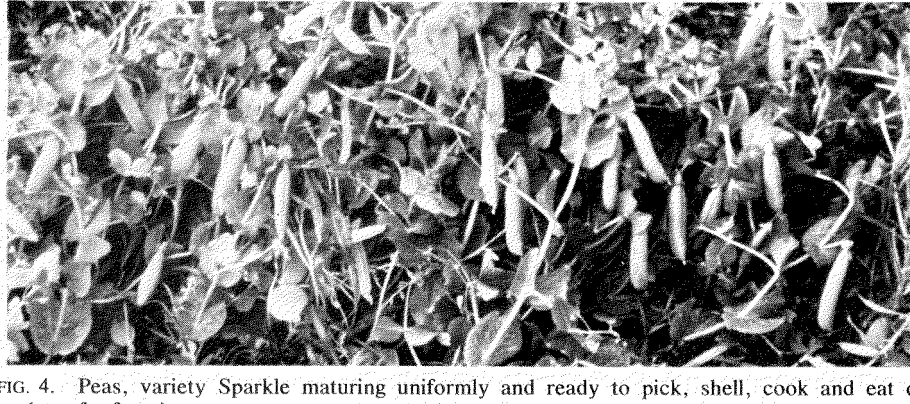

FIG. 4. Peas, variety Sparkle maturing uniformly and ready to pick, shell, cook and eat or package for freezing.

FIG. 5. Tony Schuerch in Issac Douglas' garden displaying a leaf of lettuce. The white stubs are the remains of chard that rabbits had not eaten. The 4-inch mesh wire fence in the background was too coarse to prevent rabbit entry.

Rainfall at Ambler is not sufficient for these kinds of crops, so a small gasoline-engine-driven pump and pipe to carry the water from the river to the garden were provided by funds from the Marston Foundation to assure that water would not be the limiting factor.

The success story in 1977 and in other gardens at Ambler spread up and down the Kobuk River and to villages along the Noatak and Selawik Rivers. In 1978, 250 families in the Region participated in gardening. Small, simple structures were covered with polyfilm for starting plants (Fig. 6) and film was also used in the garden at planting to increase soil temperature (Fig. 7). At Kiana, heads of cabbage in the Jackson's garden were mature on August 25th and weighed up to 15 pounds (Fig. 8). A family's supply of sauerkraut could be made from such a cabbage crop. I explained how simple it would be to make sauerkraut but it would have been another "first" and needed to be demonstrated. Cauliflower is a crop that grows very well and is of excellent quality, but mice feed at the lower side of the head and are very destructive. Carrots grow very well and develop a good root (Fig. 9). Carrots in the Eskimo diet could be nearly as important as potato because of their vitamin A content and high quality over a long storage period. A weed, tansy mustard *Descurainia sophia,* common to the region may be a real obstacle to carrot production. Linuron, a chemical weedkiller, should provide effective control since it does kill other members of the mustard family. Potatoes were good in all gardens, whether along the Kobuk or Noatak Rivers (Fig. 10). 'Alaska Frostless' (Dearborn, 1969), with its frost-resistant foliage and tubers set deep in the soil can be grown in flat culture without hilling. Its frost-resistant foliage could be just enough to prevent freezing damage on some frost nights. Turnips are a favorite food of the Eskimos and a crop well adapted to the region (Fig. 11). The turnip root maggot is the most destructive insect pest of many crucifers, especially turnip, radish, cauliflower, broccoli, rutabaga, Chinese radish, Chinese cabbage, leaf mustard and to a lesser extent brussels sprouts, rape, kale and kohlrabi. Insecticides are necessry to assure satisfactory yields of these crops in the home garden or in commercial plantings. Lettuce is a short-season crop that could be available in abundance (Fig. 12). 'Buttercrunch' variety is sensitive to the long daylight of the Arctic and shoots up a seed stalk or "bolts" early. Iceberg types of head lettuce also "bolt" early.

Summer squash and cucumber are not commonly grown by Eskimos but could be as they were quite productive in some 1978 gardens. 'Black Jack' summer squash produced good fruits and is an indicator that some winter-type squashes might grow to maturity in this Arctic region.

During the course of these studies, plants of rhubarb, strawberry and raspberry have been transplanted to the Kobuk region. It is still too early to know if the latter two will survive and be productive.

PLANS AND EXPECTATIONS

Only recently have many of the villages become aware that soils along their rivers and lakes offer them real possibilities for growing an abundance of

FIG. 6. The Black's at Shungnak using polyfilm to cover seeded rows of beans, summer squash, cucumbers and sweet corn. Sweet corn reached market maturity in this planting.

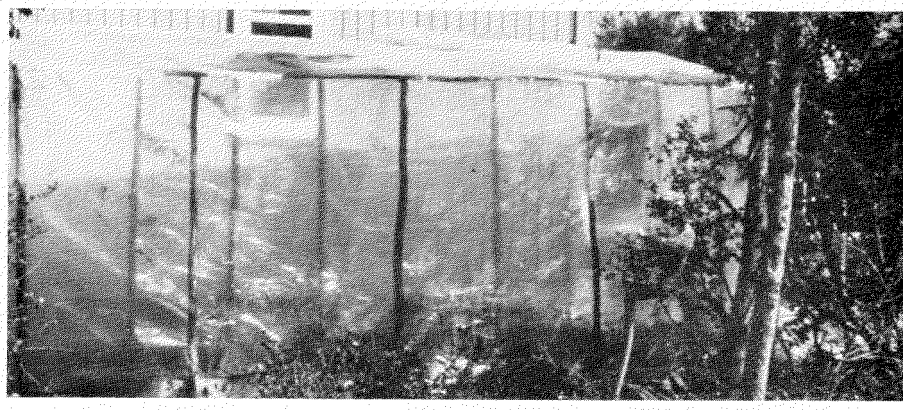

FIG. 7. Simply constructed spruce lean-to greenhouse beside Wood's dwelling at Shungnak covered with polyfilm and used for starting seedlings. Greenhouses must be fenced to keep dogs out.

FIG. 8. Henry Jackson had an excellent garden at Kiana with mature cabbage, lettuce, turnip, swiss chard, bunching onion, carrot and several potato varieties. Chemical control of weeds would have improved crop yields.

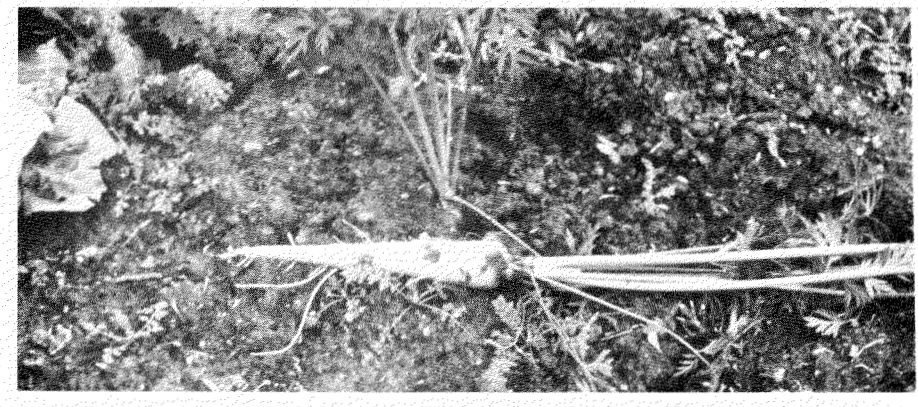

FIG. 9. Spartan Bonus carrot from Robert Cleveland's garden in Ambler showing good size with still 3 to 5 weeks to grow.

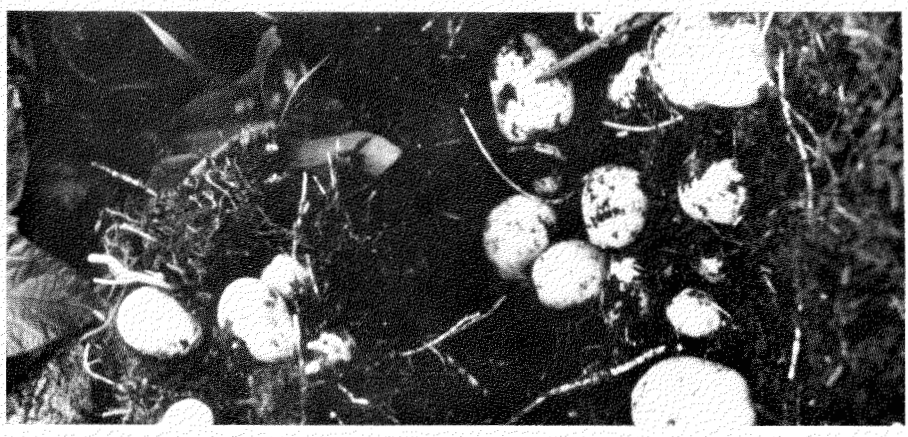

FIG. 10. Potatoes in small plots at Kiana, Ambler and Noatak were producing at an estimated rate of 10 or more tons per acre and were excellent eating quality.

Fig. 11. A 6-inch purple top white globe turnip. They grow rapidly and produce heavily when the plants are given adequate space for the tops to spread. Turnip maggots will ruin the crop if insecticides are not used.

FIG. 12. Salad Bowl leaf lettuce planted thicker than desirable yet making lush growth. Head lettuce grows well but some varieties "bolt" before a firm head is developed.

FIG. 13. The Grists' of Ambler on a clearing of their Native Allotment at Onion Portage beside the Kobuk River.

FIG. 14. Sedge tussock that is very difficult to work into the soil even after cutting and burning.

some foods. Their greatest obstacle to planting in suitable locations has been land preparation. Small walking-type rototillers provided by the Marston Foundation for land preparation in several villages have been effectively used for preparing subsistence gardens. The Grists of Ambler are shown (Fig. 13) on a tillable area of their Native Allotment at Onion Portage. Over an acre has been prepared with a walking-type rototiller that pulverizes the horsetail and sedge cover. This is the largest area ever prepared in this region for planting any crop. This virgin soil showed a pH value of 5.6 in the 6 to 8 inch tilled layer and pH 5.3 in the undisturbed lower layer. Before tilling, the vegetative cover was horsetail *Equisetum fluviatile* and the sedge *Eriophorum vaginatum* shown in Figure 14. Sedges are difficult to incorporate in the soil as their tussocks are very tough. A planting of potatoes is planned for the 1979 season on this land. There is no doubt in my mind that horsetail and sedge will be extremely competitive with potatoes. Chemical weed killers, 2,4-D and glyphosate should effectively control these weeds if applied only on the weeds as has been accomplished for strawberry culture (Dearborn, 1978). Linuron would be desirable to have on hand to use prior to potato emergence if annual grass and broad leaf weed seeds germinate. Most likely low soil moisture content will limit plant growth; therefore, mechanical cultivation should be avoided. Cultivation disrupts a dry surfact mulch and exposes moist soil to drying conditions. It would be unfair to prospective vegetable growers to overlook the possibilities that unfavorable weather conditions can occur and destroy crops. Drought, frost, hail, and wind damage, as in many other vegetable-growing regions, can be very destructive. Choice of location, crops, and of varieties plus sprinkler irrigation capabilities are ways of reducing some of these hazards.

CONCLUSIONS

Horticultural potentials of this Arctic Region look good, based on two years of trials growing what is believed to be vegetable varieties presently best adapted to Arctic climate and soils. It appears that potato, pea, lettuce, carrot, beet, Swiss chard, celery, parsley, broccoli, brussels sprouts, cabbage, cauliflower, kale, kohlrabi, radish, rutabaga, turnip, onion, chives, rhubarb and summer squash could be grown in sufficient volume to accommodate all of the people of the northwest Arctic region. Some of the crops could be stored or preserved and stored for year round use. With the use of clear polyfilm for a shelter, tomato and cucumber production in greenhouses is feasible. If polyfilm is used as a ground cover in the garden, green beans, early sweetcorn, tomatoes, cucumbers and some kinds of squashes may mature some years. Limited climatic data indicate growing conditions to be no less favorable than the climate of Clearwater where rather extensive agricultural developments are under way to produce grain essentially for animal feed.

Land preparation for the planting of family gardens has been accomplished with walking-type rototillers. Heavier equipment will be necessary to

pulverize tussocks, brush, stumps and roots of native vegetation if horticultural crops are to be grown extensively. It would be highly desirable to have one or more potato storages in the Kobuk region for holding seed potatoes from harvest to planting. Air freight charges would make seed potatoes for commercial production in this region very expensive.

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