Here we have something which is of interest to the whole Northern world. If these people left West Greenland by sea and did not return to the Eastern Settlement, to Iceland or Norway, it is inconceivable that they went anywhere but to America. It is in America that we must search for the remains of their later settlements. Whether these were in Newfoundland, Labrador, or by the Great Lakes, time alone will show, but students in America can no longer be so sceptical about Norse remains being found in their country. After all, it is only what one would expect of such an obviously hardy race as the Greenland Norsemen. They knew of a better country, and so they would surely go to it when relations with the Eskimos became impossible.

Everyone who has read *Meddelelser* and so learnt of the missing foot of Bishop Jan Smyril buried in the Cathedral at Gardar will be relieved to hear that he is no longer thought to have died of gangrene following the loss of his foot from frostbite. The foot was apparently dug off by later grave-diggers. We frequently find similar instances in Britain.

The Neanderthaloid man of mediaeval Greenland is also removed from the scope of anthropological studies. The authors of these reports consider him to have been no more than a pituitary abnormality.

The last report, by Christen Leif Vebæk, gives a clear account of the excavation of inland farms in the Julianehaab district. While the general picture is much the same as that from similar farms in Greenland, it should be noted that some typical Eskimo objects were found together with objects of Norse manufacture.

T. C. LETHBRIDGE

HYDROPONICS IN LABRADOR

[Review of a paper by H. Hill and J. Gilbey: "Soilless Culture, Production of Vegetables in Labrador", n.d. [1944], Mimeograph sent by the Experimental Farms Service of the Department of Agriculture, Ottawa.]

In recent years, a considerable amount of experimental work has been directed, particularly in America, towards the cultivation of plants without soil, on an amateur and also on a commercial scale, a study to which the name "hydroponics" has been given. Details of the methods employed and results obtained, together with a discussion of the potentialities of this technique, may be found in the works of Gericke (*Soilless Gardening*, 1940), of Ellis and Swaney (*Soilless Growth of Plants*, 1938), and Turner and Henry (*Growing Plants in Nutrient Solutions*, 1939). In general, two methods of culture are in use; in one, the water-culture method proper, the plants are supported with their roots growing in the nutrient solution; in the other, sand, gravel or cinders form the rooting medium to which the nutrients are supplied as solid fertiliser or as solution. The first method has the disadvantage of requiring artificial aeration of the solution to support root growth.

The particular applicability of the hydroponic method of cultivation to Arctic conditions is shown by the paper of Hill and Gilbey here reviewed. They describe experiments at Goose Bay in Labrador, where the dominant vegetation is dwarf spruce and Ericaceous shrubs, and the soil is an acid "podsol" consisting of a thin layer of raw humus over leached sand. In such a place the establishment and preservation of a reasonably fertile garden soil is at the best a long and arduous process. For quick-maturing crops it is not the climate which is the limiting factor. The records showed no frost from 17 June until 28 September, when a night frost killed the tops of the potatoes, and during this period "generally good growing weather prevailed, though periods of overcast, cool weather were frequent". The long hours of daylight during the summer months also favour rapid growth.

In these experiments a number of "surface-fertilised" sand beds, and a single "sub-irrigated" sand and gravel bed, were used. The surface-fertilised beds were of wood, 100 ft. × 5 ft. × 8 in., raised on trestles 2 ft. 6 in. from the ground, and filled with 7 in. of medium sharp sand. The original plan was to apply nutrient solution at regular intervals by spraying the sand surface; but owing to equipment difficulties, the chemical fertilisers had to be applied in the solid form and cultivated in. Watering was carried out as necessary with a hose. The single sub-irrigated bed was of the same dimensions but made of cement. It was provided with two inlets at the bottom. One pipe was connected to an electrically-driven centrifugal pump, the other to a waterproofed concrete tank containing the solution, which was pumped into the bottom of the bed and distributed evenly under an inverted trough. The bed comprised 5 in. of crushed stone and a top 2 in. of sand; the solution rose in this and returned to the tank from an overflow pipe at the top of the bed. Periodic analyses of the contents of the tank were performed, and the solution built up to its original strength or replaced.

The chemical fertilisers used were standard mixtures employed at the Ottawa Central Experimental Farm. The solid fertiliser consisted of:

Ammonium sulphate $(NH_4)_2SO_4$	14 lb. 2 oz.
Muriate of potash KCl	3 lb. 12 oz.
Superphosphate $Ca(H_2PO_4)_2$ 20%	3 lb. 5 oz.
Magnesium sulphate $MgSO_4$	3 lb. 7 oz.
Boric acid H_3BO_3	2½ teaspoonfuls
Manganese sulphate $MnSO_4$	1 teaspoonful
Ferrous sulphate $FeSO_4$	3 teaspoonfuls

Initial applications of lime were necessary to counteract the acidity (*p*H 5·0) of the sand, but since lime applied to the surface yields a hard crust harmful to plant growth, it would probably have been better to mix powdered slaked lime with the sand (25 lb. per bed) when the fertiliser was first prepared. The fertiliser was applied to the surface at weekly intervals at a rate of 5–10 lb. per bed.

For the sub-irrigated bed, the 700 gallons of solution required to flood the bed was made up with the following quantities of chemicals:

Ammonium sulphate	6 lb. 6 oz.
Muriate of potash	1 lb. 12 oz.
Superphosphate (20%)	2 lb.
Magnesium sulphate	1 lb. 1½ oz.
Boric acid	17·5 grm.
Manganese sulphate	1·75 grm.
Ferric chloride $FeCl_3$	12·0 grm.

The calcareous stone used was found to precipitate the iron and phosphate from the nutrient solution, and repeated floodings were necessary before the solution remained unaffected. This was later avoided by first treating the bed with a very dilute solution of sulphuric acid or calcium hydrogen phosphate.

The absence of nitrate from the fertiliser formulae is surprising. Hill and Gilbey suggest that it should be included. All the standard mixtures given in the works quoted above include nitrate, usually as the calcium salt. Ellis and Swaney, for example, quote the following constitution for a solution used in the sub-irrigation method by the Purdue University Department of Horticulture:

	K_2SO_4	$MgSO_4$	$Ca(H_2PO_4)_2$	KNO_3	$(NH_4)_2SO_4$
Grammes per 5 gallons of solution	5·6	7·3	8·6	12·0	4·0

(Boron, manganese and iron are usually present in sufficient quantities as impurities in chemicals of commercial grade, and were not specifically added here.)

Details of the crops and varieties grown are given in the paper. In most cases, the seeds were sown in rows in the beds and seedlings thinned out to the usual distance; cabbage was sown in sand "flats", and transplanted into the sub-irrigation bed. Potatoes were planted 15 in. apart in the beds. With the exception of cabbage, sowings could not be made until the beginning of July, when germination was good and rapid. The following list of seeds and germination periods is of interest:

Crop plants	Variety	Germination period (days)
Leaf lettuce	Grand Rapids	7
Spinach	Bloomsdale Early Market	8
Beet	Detroit Dark Red	8
Beans	Pacer	7
Radish	Scarlet Globe	4
Potato	Cobbler	7
Carrot	Chantenay	10
Turnip	Laurentian	10
Cabbage	Golden Acre	7

There was virtually no weed growth in either type of bed. Two insect pests did, however, occur; but no details of the extent of the attacks are given. It seems likely that in large-scale repetitions of these experiments, spraying with insecticides would be advisable.

The authors suggest in their discussion of the results that the sub-irrigated bed has many advantages over the simple type. Considerable difficulty, for example, was experienced in maintaining a nearly constant concentration of fertiliser in the soil in the latter, owing to the leaching action of the frequent heavy rains, so that nearly three times as much fertiliser was used per unit area (5 tons per acre) as compared with the sub-irrigated bed ($1\frac{3}{4}$ tons per acre). In spite of the higher cost of installation, it is felt that the sub-irrigated bed is in the long run more practical, more economical in labour, allows closer planting and yields more heavily. Moreover, a considerable degree of temperature control is possible with sub-irrigation, the nutrient solution being delivered at the optimum growing temperature. In the actual experimental beds used, the only control effected was to avoid temperatures below freezing-point by building the beds above the ground level. In these latitudes the subsoil may remain frozen when air temperatures are constantly above 0° C.

As examples of crop yield, the following data may be quoted:

Radish sown 2 July, mature crop harvested 3 August; average yield per bed = 650 bundles of 12.

Lettuce sown 3 July, cut 16 August. There is little doubt that with earlier sowing, two successive crops could be matured.

Spinach—performance similar to lettuce.

Cabbage sown 21 June, transplanted into bed early in August; made rapid growth, but produced only small heads. Could be easily matured if seedlings were raised under glass.

Potatoes set 3 July, grew until 28 September, when the first heavy night frost killed the tops; yielded an average of 3 bushels of marketable and two of undersized potatoes per bed.

The authors point out that with earlier sowing in the first week of June, when the danger of heavy frost is virtually over, more than three months of reasonably good growing weather would be available, sufficient to bring to maturity all the crops employed in the experiment.

The importance of these experiments, incomplete though they are, is considerable, and repetition, with earlier sowing, would well repay the investigators. The results, moreover, provide a basis on which, with a minimum of equipment, small-scale experiments in vegetable cultivation could be carried out at isolated stations in the Arctic and Antarctic. As Hill and Gilbey point out in their concluding remarks: "although installation costs are high, production is economically sound when the cost and percentage spoilage of imported produce is considered. It is possible that in other areas of unproductive soil, sufficient produce could be raised to prevent nutritional diseases in communities engaged in the exploitation of mineral and other natural resources."

S. MAX WALTERS

HARDNESS OF ICE AT LOW TEMPERATURES

[Summarised from an article by Eliot Blackwelder in the *American Journal of Science*, Vol. 238, No. 1, 1940, pp. 61–62.]

It has long been known that ice is subject to great varieties of hardness according to temperature. According to observations recorded by Carl Teichert in 1939, the hardness of ice increases from about 2 (on the Mohrs scale) or less at temperatures near freezing-point, to 4 at a temperature of −44° C., and should be about 6 at −50° C. As this report seemed to rest only on field observations made by Albrecht Heim in the Alps and later by Alfred Wegener in Greenland, it was desirable to have confirmation. Dr E. Blackwelder therefore arranged for Mr Ira Klein to make careful scratching tests in a