**Reijo Solantie**

# CLIMATIC CONDITIONS FOR THE CULTIVATION OF RYE WITH REFERENCE TO THE HISTORY OF SETTLEMENT IN FINLAND

*Abstract*

In Finland the grain cultivation economy brought about a change in the pattern of settlement from even dispersal to a clustered one. The basic hypothesis of this study maintains that with the grain cultivation economy settlement sought its way first into areas that were climatically the most advantageous for the growing of rye and spread gradually through the various climatic regions to the less suitable areas. Regional traits of settlement in the various periods concerned can be explained in terms of present climatic conditions. The results also suggest climatic factors possibly explaining differences in the spread of settlement in Western Finland on the one hand and in the region of Savo on the other. These take as their starting point the differences of the burn-beating rye species grown in Savo and the Scandinavian-type arable rye cultivated in Western Finland. The same explanation also applies to the areas of Norway and Sweden settled by farmers from Savo in historically documented times. It is also suggested that the first settlers of the north-western part of the present province of Uusimaa (Sw. Nyland) in Southern Finland came from regions to the east of the Kymijoki River. This is in agreement with the climate of the Uusimaa region, the slash-and-burn farming culture, farming terminology and the properties of the burn-beating variety of rye cultivated.

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## INTRODUCTION

Throughout long periods in prehistory as well as historically documented times permanent settlement in Finland based on the cultivation of grain was restricted to certain regions. This pattern differs clearly from that of settlement based on hunting and fishing. The boundaries of settlement and its spread or retreat through definite successions of regions are problems of research that are unanswered to a great degree. In the present study these problems are approached from the perspective of the climatic conditions necessary for the cultivation of rye. Rye was a main species of grain cultivated in Finland from the beginning of grain cultivation until the end of the so-called natural, i.e. non-market, economy. Rye is considerably more demanding of climatic factors than barley and is thus a more reliable indicator of the mutual relationship of settlement and climate.

Accurate climatic data is available from only the 19th century onwards. For this reason it is important to know how the present regional features of the risks of rye cultivation can be applied to climatic conditions in the different stages of this means of livelihood. In England, for example, mean temperatures over periods of about a century have not varied more than 1.0°C from the present in any climatic phase of the past 3,000 years (Lamb 1982). However, climatic changes of even this degree have definite effects on the risk levels of cultivated plant species. On the other hand, the main factors in the study of regional patterns of succession in the spread of settlement, viz. the differences of risks and their order of magnitude among different areas, are not subject to change even with overall changes of climate (see DISCUSSION, below).

The development of permanent settlement in Finland shows an unbroken succession from the

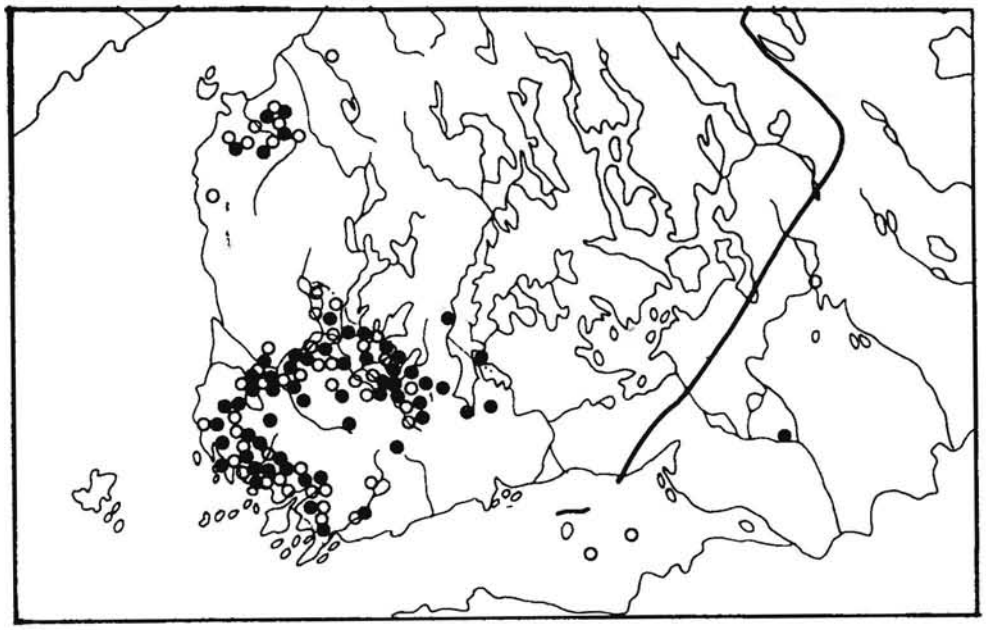

*Fig. 1.* Migration period (ca. 400-600 A.D.) and Merovingian period (ca. 600–800 A.D.) cemeteries (Huurre 1979).
○ Migration period cemeteries
● Merovingian period cemeteries

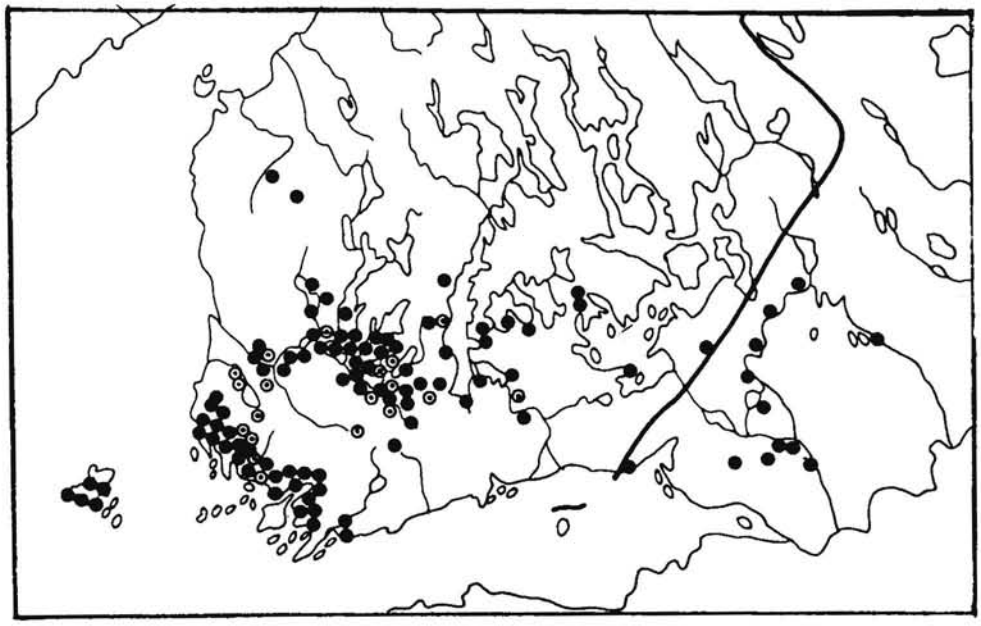

*Fig. 2.* Viking period cemeteries, ca. 800–1050 A.D. (Huurre 1979)
● Cremation burials
◎ Inhumation burials

Roman Iron Age to the present day. In the initial period both barley and rye are known to have been grown (Tolonen 1978, Vuorela 1975, Nuñez & Vuorela 1976). Settlement of this period indicates clearly the regional pattern of settlement that followed (Figs. 1 & 2; Huurre 1979).

## POST-IRON AGE PHASES OF SETTLEMENT STUDIED

In the Iron Age the coastal regions of SW Finland, protected by the surrounding archipelago, were permanently settled. On the other hand, the seaboard of the Gulf of Finland with less sea-

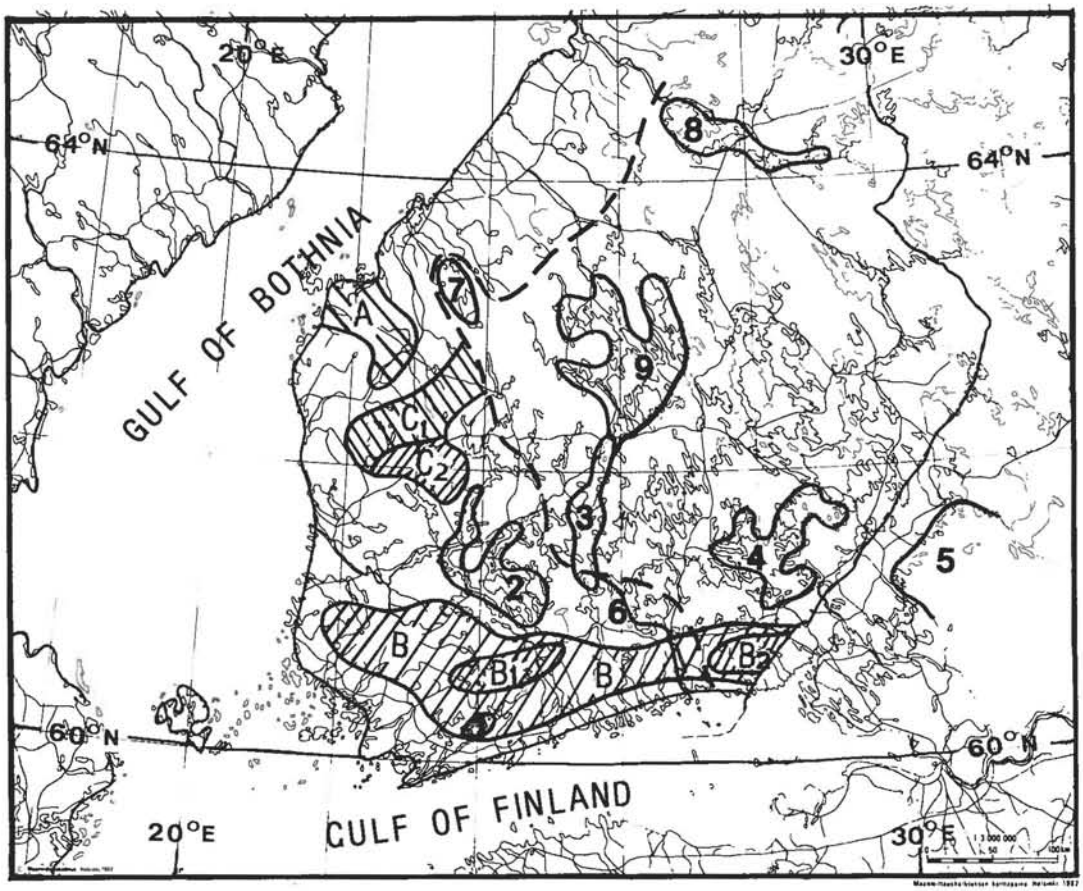


*Fig. 3.* Geographical areas referred to in text (see also Fig. 4)

Regions (hatched)

Bread grain zone:

| | | |
|---|---|---|
| A | = | The Kyrönmaa region in Southern Ostrobothnia. NW part of the bread grain zone |
| B | = | Inland regions of Southern Finland |
| $B_1$, $B_2$ | = | Subdivisions of B with greatest wintering risks for rye. Last burn-beating areas of B. |

SW part of the feed grain zone

| | | |
|---|---|---|
| $C_1$ | = | Southernmost tar-burning area of Finland in the 1850s, high frost risk for rye cultivation. |
| $C_2$ | = | Separate area of old settlement from Savo, climatically favourable for the burn-beating variety of rye |

Bodies of water

| | | |
|---|---|---|
| 1 | = | Lake Lohjanjärvi |
| 2 | = | Large lakes of Central Häme |
| 3 | = | Lake Päijänne |
| 4 | = | Lake Saimaa |
| 5 | = | Lake Ladoga |
| 6 | = | Kymijoki River |
| 7 | = | Lake region of Lappajärvi |
| 8 | = | Lake region of Kainuu |
| 9 | = | Northern large lakes feeding the Kymijoki River |
| – – – – | = | Western boundary of Savo dialects |

ward protection was still without permanent settlement by the end of the Iron Age (Figs. 1 & 2). This lack of settlement on the southern coast has been explained as a result of restless conditions. The inland regions of Southern Finland, both in the south and south-west, were also without settlement (Fig. 3, Area B). The wilderness areas extended to the settlements of the Kokemäenjoki River, the lake region of Häme and the Päijänne – Saimaa lakes region in the east. On the other hand, if there had been a potential threat to settlement from the sea, would not the uninhabited inland of SW Finland have been more secure than the coast despite the protection afforded by its outlying archipelago? The Swedish settlers of early medieval times kept to the coast to an even greater degree than the SW Finns. Orrman (1987) has suggested that the Swedes were capable of cultivating the gyttja clay soils of these areas, but not the heavier clayey soils of the inland (Eronen 1974, Kurki 1982). The area of heavier clays borders on the Litorina clay zone of the coast only in the eastern part of the province of Uusimaa. In the inland of western Uusimaa the soils are especially easy to cultivate with fine sandy till predominating in the fields (Kurki 1982). In these regions there are also areas of lake mud soils which were also occupied and utilized by the earliest settlers (Jussila 1977).

The coast, the shores of large rivers and the regions of the large lakes were all especially suitable for settlement not only because of their opportunities for fishing but also because of the fact that the bodies of water facilitated communications and transport within the areas concerned. The regional distribution of Iron Age cemeteries shows that for some reason settlement was more dense in the coastal regions of SW Finland, along the Kokemäenjoki River and in the vicinity of the large lakes of Central Häme than in the valleys of Lakes Saimaa and Näsijärvi. A further problem is the origin of a separate pocket of settlement in Ostrobothnia in the Early Iron Age and its disappearance at the end of the Viking period (Fig. 3). A central problem, hitherto unanswered, is the expansion of settlement in Savo in comparison to that of the Häme regions. Related issues are also the routes of the spread of settlement in Savo and the subsequent formation of the border between East and West Finnish settlement.

## THE CULTIVATION OF RYE IN PRESENT CLIMATIC CONDITIONS

The northern boundary of the so-called feed grain zone can also be regarded as the northern limit of rye cultivation (Rantanen & Solantie 1987) (Fig. 4). At this boundary, the growing season in even slightly less favourable years is so short and cool that rye cannot mature before the period is over.

Even with a growing season of sufficient duration, rye is also threatened by servere summer frosts and the damages of wintering. In summer rye is sensitive to night frosts until its grains harden in late July – early August. All of the varieties of rye grown in Finland are resistant to the effects of too small amounts of snow in winter (ice-scorching and severe frosts). On the other hand, in winters with a thick snow cover forming before the ground freezes properly and consequently remaining unfrozen for most of the winter, snow mould destroys the sprouts (Mukula & Rantanen 1987). In Southern Finland this can happen in mild winters even if the snow cover is not very thick. In the feed grain zone the risks of frosts and wintering either jointly or separately are usually considerable and in the poorest years the growing season is too short. Thus, in this zone rye cultivation is viable only in the most advantageous locations and using the best possible varieties. On the other hand, in the so-called bread grain zone of Southern Finland (Fig. 4) the growing season is sufficient for rye with only rare exceptions. However, the joint damages caused by night frosts and wintering make rye cultivation considerably risk-prone in certain parts of even this latter region.

## METHOD

The growth conditions of rye in the present climate were first studied. Following this, the regional differences of the risks of rye cultivation were applied to explaining the spread of permanent settlement in Finland. The starting point in this connection was that at first areas with little or no risk were settled after which settlement spread to areas of progressively greater risk. A chronological succession appeared natural. However, the areas of Western Finland and Savo were investigated separately. In both cases the environmental risks of rye cultivation were first defined for the arable and burn-beating rye

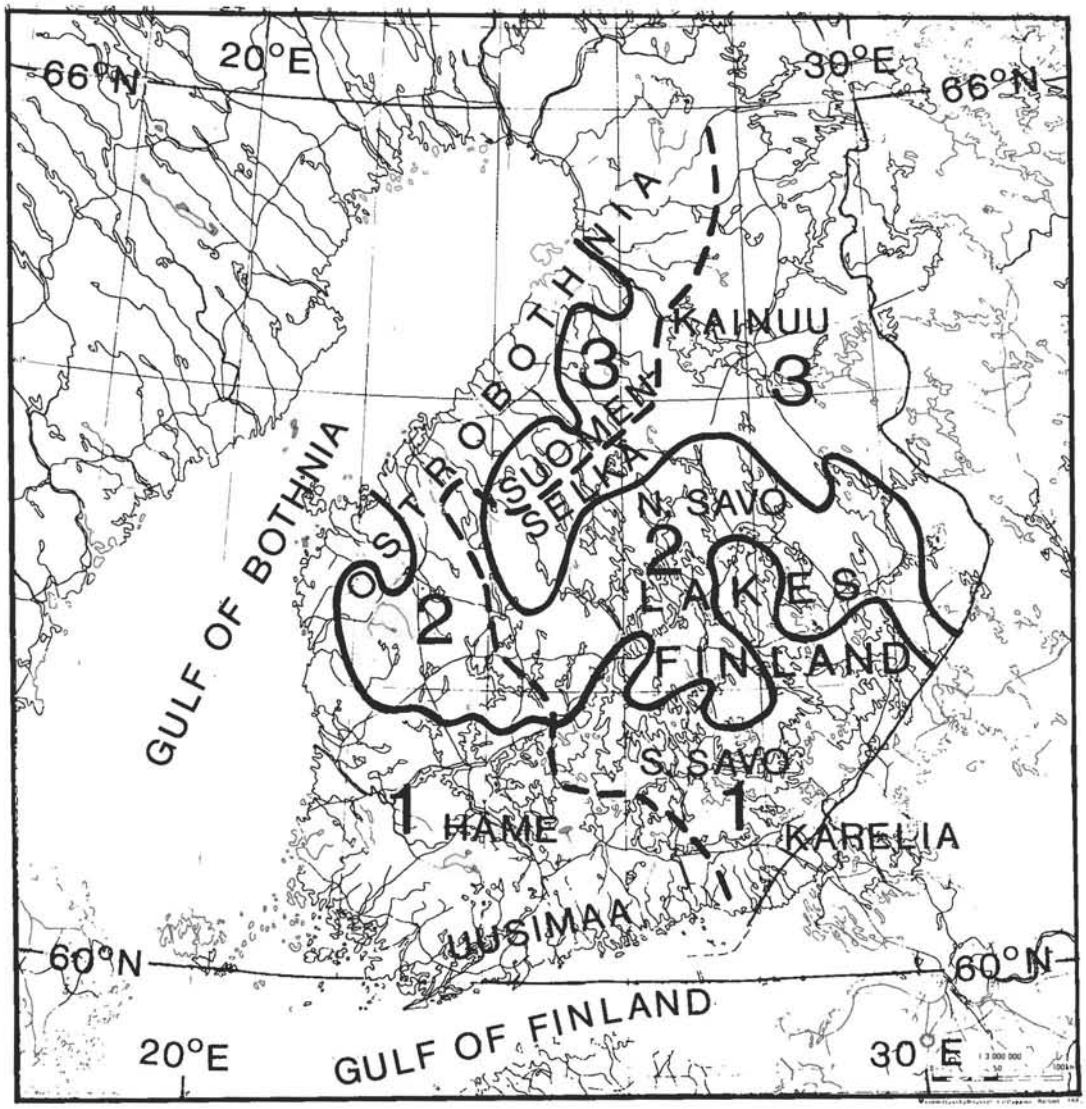


*Fig. 4.* Cultivation zones (1, 2, 3) and provinces of Finland.

| | | | | | |
|---|---|---|---|---|---|
| 1, 2, 3 | —— | = Climatic cultivation zones with boundaries | 2 | = | Feed grain zone |
| | | | 3 | = | Grasses cultivation zone |
| 1 | | = Bread grain zone | ---- | = | Western boundary of Savo dialects |

varieties respectively. It was also investigated to what degree the varying climatic requirements of these varieties affected the formation of boundary of West Finnish settlement and that originating from the Savo region. The chronological upper limit of this study is the climatic catastrophe of the 1860s, which brought about the end of rye-based agriculture and the resulting pattern of new settlement.

Finally, there is a critical review of the possibilities of applying data on rye cultivation under present climatic conditions to climatic phases in historical times.

The climatic requirements of rye grown in the Merovingian and Viking periods were assumed to have been the same as those of the Scandinavian-type of rye grown in Western Finland, known in Finnish as arable or "field" rye (Soi-

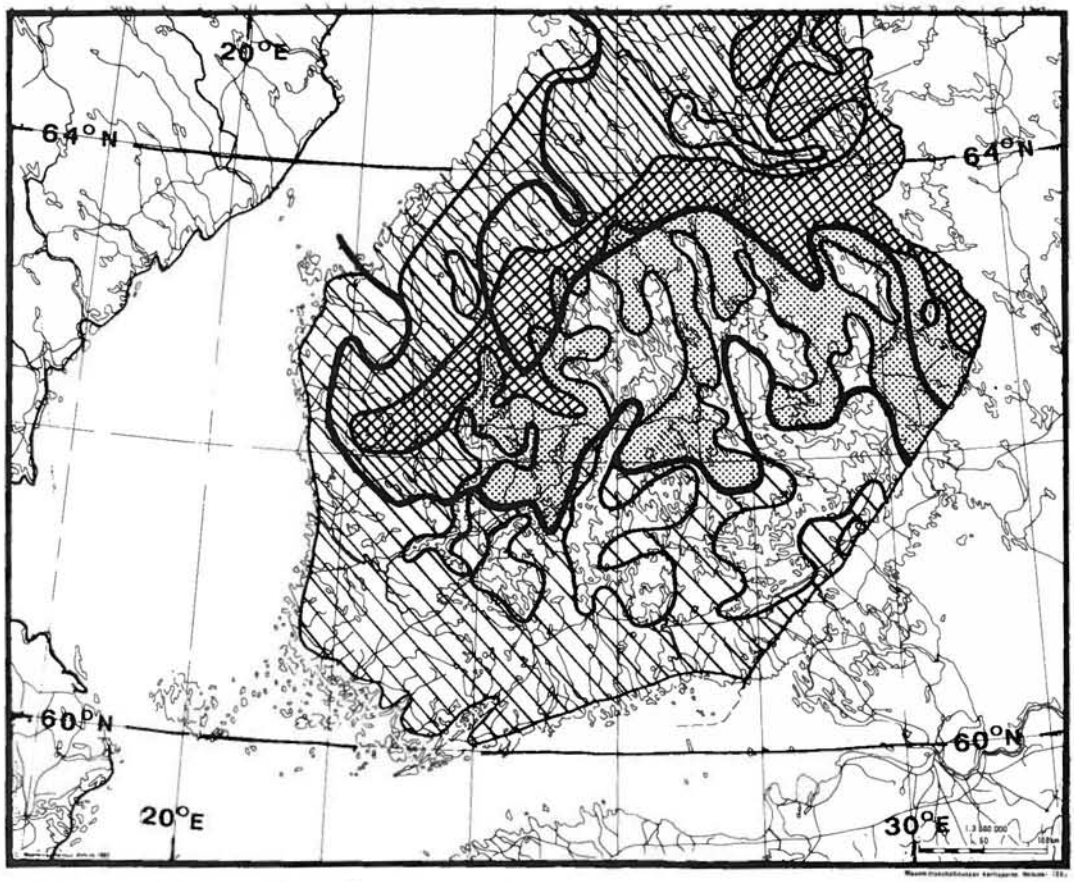


*Fig. 5.* Frost risks for rye cultivation[1], i.e. probability for absence of severe frosts for:

| | 65 days or less (adverse effects on arable rye) | 75 days or less (adverse effects on burn-beating rye) |
|---|---|---|
| ( □ ) | = 0– 4 % | 0– 9 % |
| ( ▨ ) | = 5–14 % | 10–24 % |
| ( ⁘ ) | = 5–24 % | 10–39 % |
| ( ▨ ) | = 15–24 % | 25–39 % |
| ( ■ ) | = over 24 % | over 39 % |
| ▬ | = Northern boundaries of the bread and feed grain zones (thick lines to the north and south respectively) | |

[1] The frost risk of burn-beating rye also indicates its total risk.

ninen 1974). The total risk involved was defined as the sum of the frost risk and the wintering risk. The frost risk of rye (see Fig. 5) is approximated as the percentage of all summers with an absence of severe frosts shorter than 65 days (Data in Solantie 1987; On the properties of arable rye see Mukula 1981, Rantanen 1979). The wintering risks of rye (see Fig. 6) are approximated as the proportion of winters when the ground does not freeze (data in Solantie 1985). The risks for burn-beating rye are given below.

## MAIN INVESTIGATION: RISKS OF RYE CULTIVATION IN THE VARIOUS PHASES OF THE SETTLEMENT OF FINLAND

### *Settlement of the Merovingian and Viking periods*

Due to low population in the Merovingian and Viking periods the best locations for habitation and cultivation could be freely chosen. Hunting, fishing and burn-beating offered ways of exploiting the resources of wilderness areas located be-

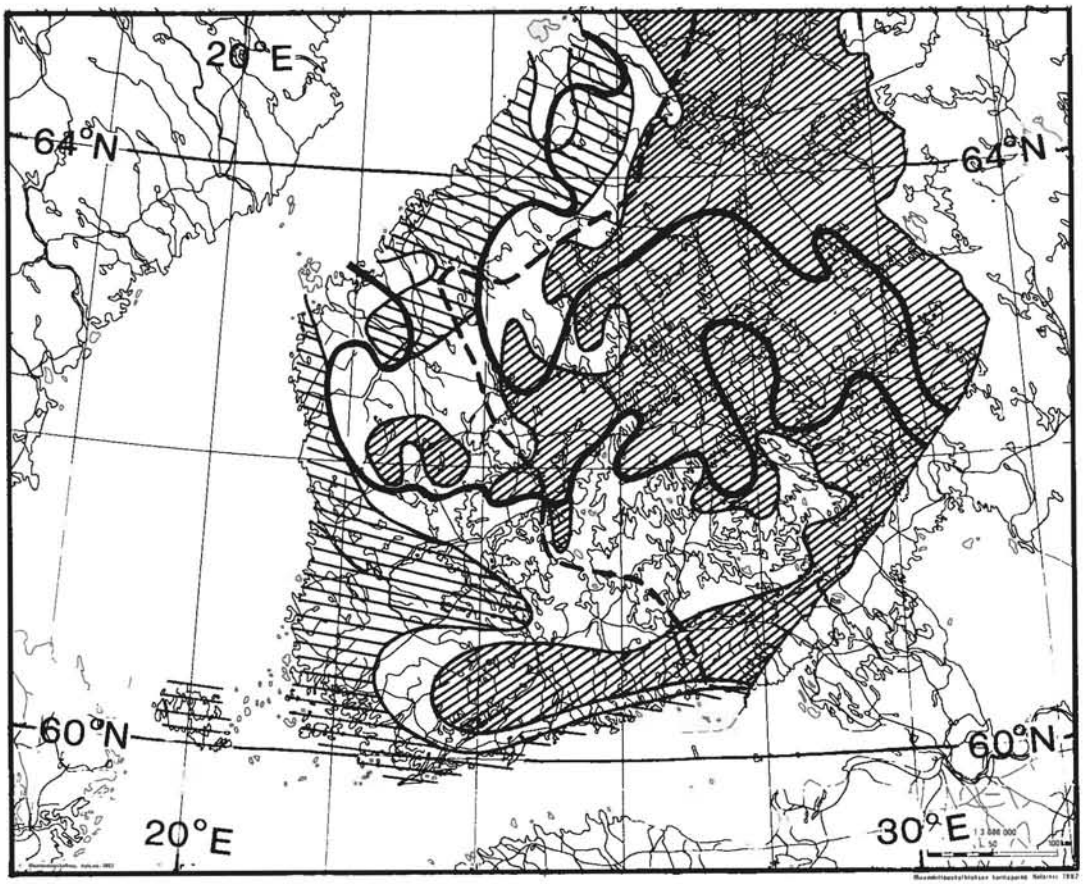


*Fig. 6.* Wintering risks for arable rye, i.e. proportion of winters when the ground does not freeze.

( ▨ ) = 1–4 %
( □ ) = 5–10 %
( ▨ ) = 11–25 %
—— = Northern boundaries of the bread and feed grain zones (thick lines to the north and south respectively)
– – – = Western boundary of Savo dialects

tween inhabited locations. At this stage, the risks of cultivation and those encountered by private households appear to have been the smallest ever in the period of the non-market economy. Practically all cemeteries indicating settlement of the Merovingian and Viking periods are in the present so-called bread grain zone (Fig. 4).

The total risks of the cultivation of arable rye are shown in Fig. 7. These risks vary from 1–4 % to over 20 %. The permanent settlement of the Merovingian and Viking periods (Fig. 1 & 2) occupies more or less the areas where the total risk of rye cultivation falls below 10 % and the largest villages were in regions where it is less than 5 % (Fig. 7). There are, however, exceptions. The narrow coastal zones of the Gulf of Finland and the southern parts of the Gulf of Bothnia where the total risk is less than 10 % remained uninhabited. On the other hand, Southern Ostrobothnia (Fig. 3) where the above-mentioned risk is greater than 10 % was uninhabited in the Viking period, but not in the preceding Merovingian period (Figs. 1 & 2).

In the areas of the oldest Iron Age settlement the thin snow cover offered other, secondary, benefits for living in addition to low wintering risk for arable rye. The unfrozen ground under the thick snow cover is hard to negotiate by horse especially when the snow cover extends to

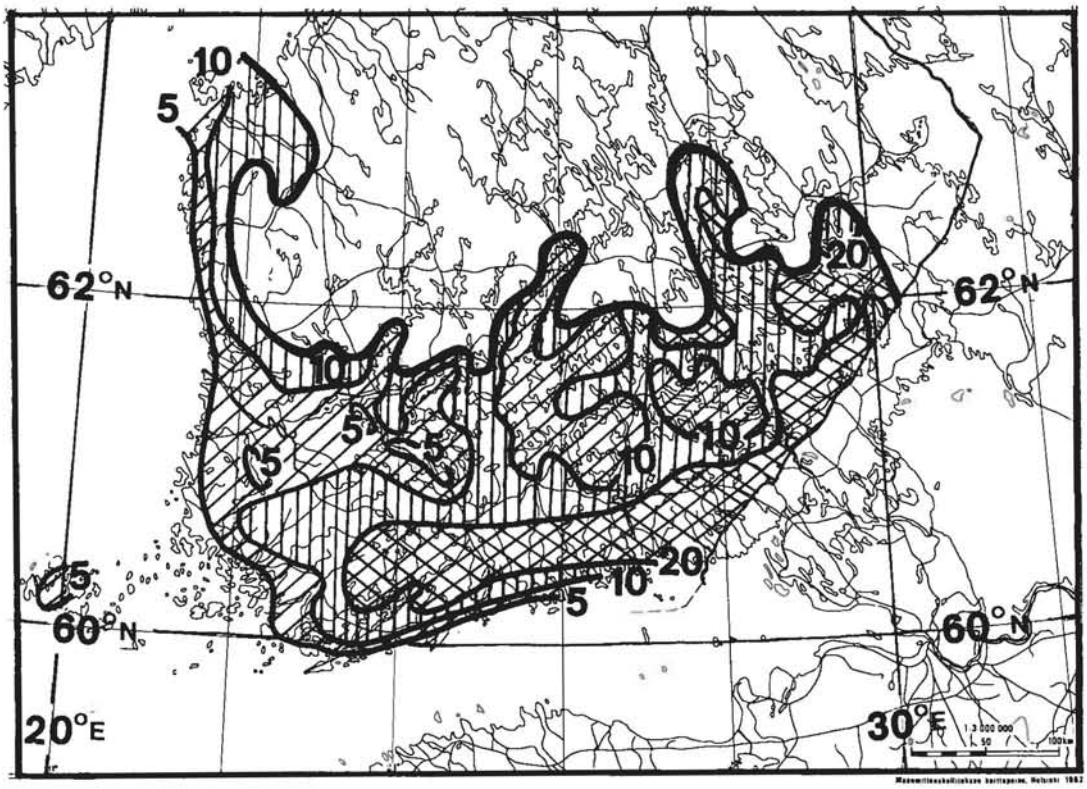


*Fig. 7.* Total risk of arable rye cultivation in the bread grain zone.

= 1–4 %
= 5–9 %
= 10–19 %
= 20 % or greater
= Northern boundary of the bread grain zone

the horse's knees to a height of over 50 cm. The isopleth indicating the 5 % wintering risk for rye (Fig. 6) corresponds more or less precisely to the isopleth for maximum snow thickness (47 cm) of an average winter (Solantie 1978). In the Merovingian and Viking periods permanent settlement was mainly to the south-west of the present isoterm for the mean January temperature of −8° C, viz. within a region where heating did not entail undue difficulties.

### *The Iron Age settlement of Southern Ostrobothnia*

The present frost risk for the cultivation of arable rye in the most advantageous inland area of Southern Ostrobothnia, Kyrönmaa, (Fig. 3) is ca. 5–14 % while the corresponding figure for other areas settled in the Merovingian period is less than 5 %. The wintering risks of rye (Fig. 6), however, are small in Southern Ostrobothnia. Thus, the total risks of rye cultivation which are less than 10 % in other areas of Merovingian period settlement, remain at tolerable levels (ca. 10–19 %) in this part of Southern Ostrobothnia (Fig. 7). In Southern Ostrobothnia rye was cultivated alongside barley as also in Häme at the same time (Miettinen & Vuorela in this volume, Vuorela 1986, Vuorela & Lempiäinen 1988). Due to its thermal conditions, however, the Kyrönmaa region of Southern Ostrobothnia is at the very border of low-risk rye cultivation.

In this region grain cultivation even today entails considerable risks and adverse conditions set in immediately when the climate becomes even slightly cooler. If the mean temperature of the growing season decreases with an average of 0.5°C for a longer period the risk of frosts in-

creases to ca. 30 %. If the mean temperature decreases 1.0°C the corresponding risk of frosts increases to 40-50 %. At the same time the growing season becomes shorter and the sum of effective temperatures decreases to such a degree that in poorer summers rye will not ripen.

In Norway, Greenland and the British Isles the Viking period was especially advantageous for the cultivation of plants, whereas in Central Europe conditions were in fact too warm and dry (Lamb 1982). Lamb suggests that this may have been the result of warm high-pressure conditions (so-called blocking high) that occurred more often than usual and more intensively in its main areas of occurrence, viz. in the eastern parts of the North Atlantic and in NW Europe. Cold air often flows into Finland from the Arctic Ocean to the east of the high which increases the risk of night frosts. Thus, the rise in the risk-level of rye cultivation above a tolerable level in the early Viking period was quite possible especially in Southern Ostrobothnia where the risk of night frosts is considerable even otherwise. This also increases the possibility of increasing risks affecting settlement.

*The westward and northward spread of settlement from Savo and the boundary with respect to West Finnish settlement*

In Southern Finland the wintering risks of arable rye increase towards the east so that in Eastern Finland regions suitable for settlement in the Merovingian and Viking periods (possibly originating from Häme) are mainly found to the east of Häme only in the valleys of Lakes Päijänne, Saimaa and Ladoga (Fig. 3).

All in all, settlement from Häme spread slowly from previous centres, especially in comparison with the expansion of eastern settlement (Soininen 1961) which occupied the eastern regions of the settlers from Häme and continued to the north-west through the wilderness areas utilized by the latter.

The settlers of Häme grew a Scandinavian type of arable rye (Soininen 1974). In swidden agriculture a burn-beating variety of rye of Russian origin was also grown (Soininen 1974). It spread from Karelia along with the Savo settlers (Soininen 1961) and was not known in Häme at least in the Merovingian and Viking periods and not even later as a pure variety. The burn-beating variety of rye did not thrive in field cultivation (Soininen 1974), it gave, however, an excellent yield in the burn-beating plots. This may be due to three factors. First of all, the burn-beating variety sprouted to a considerable degree. Secondly, it was resistant to rust fungus so that it could be sown at an early stage and grow sprouts poperly (Soininen 1974). On the other hand, it did not grow as densely as the arable variety (Valle 1931) which was advantageous in preventing the spread of snow mould (Rantanen 1979). According to experiments conducted, burn-beating rye will winter considerably better than the arable variety (Valle 1931). The yield of burn-beating rye was not as small as could be expected of its small grain size and sparse growth, because the crop was excellent in relation to the amount sown (Soininen 1961). This was naturally an advantage in providing sufficient seed-grain after crop failures. The burn-beating variety of rye heads ca. 12 days later than the arable variety and ripens approximately 8 days later (Valle 1931) and is thus more susceptible to night frosts. In assessing the total risk of burn-beating rye cultivation as the sum of the wintering and frost risks the former can be estimated as nil and the latter as the proportion of years when the absence of severe night frosts is less than a period of 75 days.

In the easternmost centres of Viking period settlement originating from Häme, i.e. the valleys of Lakes Päijänne, Saimaa and Ladoga (Figs. 1, 2 & 3), the night frost risk for rye, regardless of variety, is practically nil which is also the case in the lakes region of Central Häme (Fig. 3). On the other hand, the wintering risks for arable rye increase towards the east. Thus, the valleys of the large lakes to the east were risk-free for only the burn-beating variety of rye, in the same way as the lakes region of Central Häme was risk-free for the growing of arable rye. In all of the watershed areas to the east of the large lakes of Central Häme, the total risk for arable rye is 10–19 % (Fig. 7) and that of burn-beating rye is the same or less (Fig. 5).

The settlements of Savo came about in the southern parts of the Lakes Region of Finland along with the spread of settlers from Karelia through the easternmost areas originally settled from Häme. These groups of settlers became intermixed at the end of the Viking period (Vilkuna 1960). Having come about in this way, the Savo settlements spread westward with the aid of burn-beating rye to the watershed dividing Lake Päijänne from the large lakes of Central Häme.

The expansivity of pioneer settlement based on the growing of burn-beating rye is largely a result of the fact that in swidden agriculture

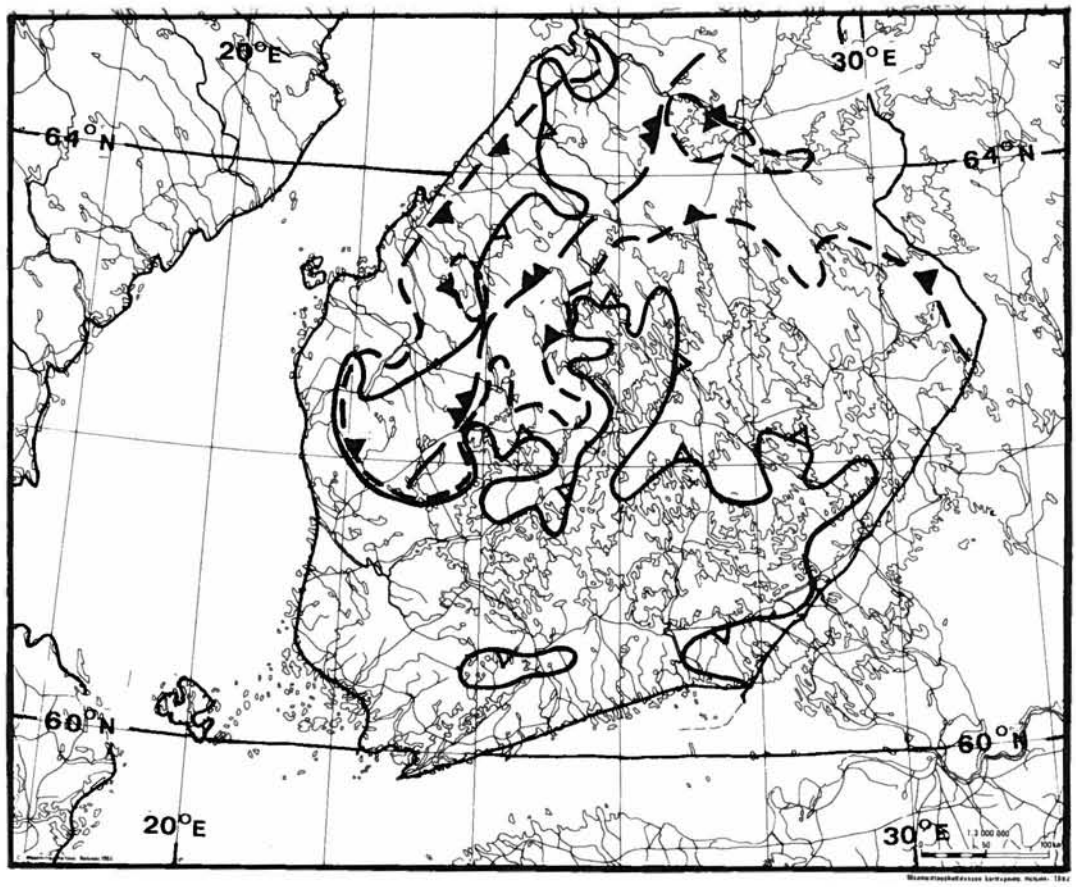


*Fig. 8.* Climatic boundaries of rye cultivation

(—△—) = Boundary at which total risk for arable rye cultivation is 25 %
Triangle indicates direction of greater risk.

(-▲--) = Boundary of 25 % total risk for the burn-beating variety of rye (equal to frost risk). Triangle indicates direction of greater risk.

(▲▲—) = Boundary to the south-east which supra-aquatic moraine hills and ridges occur. In these locations the total risk for burn-beating rye cultivation is less than 25 %.

burn-beating rye gave only a single crop in the same location. Accordingly, the environs of a farm site would provide burn-beating plots for a period of 20–30 years (Soininen 1961, Vilkuna 1953). In my opinion, the unsuitability of burn-beating rye for field cultivation can explain Soininen's (1961) observation that in the oldest Savo settlements based on continuous cultivation barley became the main grain species grown.

For centuries the northern boundaries of both Häme and Savo settlement (Soininen 1961) extended to the climatic obstacle formed by the northern limit of the bread grain zone (Fig. 4). From ca. 1475 to 1510 settlement spread rapidly along with the increase of population as well as increased taxation to the north-west (Soininen 1961), i.e. to the feed grain zone (Figs. 4 & 9). This zone can be subdivided into two separate areas, Ostrobothnia in the west and the northern part of the Lakes Region in the east. Throughout nearly all of the northern part of the Lakes Region arable rye could not have wintered (Figs. 6 & 8). Unhindered by these difficulties, burn-beating rye thrives in areas where the night frost risk is only 5–15 %. These areas are the shores of large lakes and hillsides (Solantie 1987). In both locations there are dense stands of spruce favourable for the growing of burnbeating rye (Soininen 1961). The hillsides in these areas are supra-aquatic, i.e. unleached moraine soils.

In Ostrobothnia there are no lakes or high hills that would help prevent night frosts. The

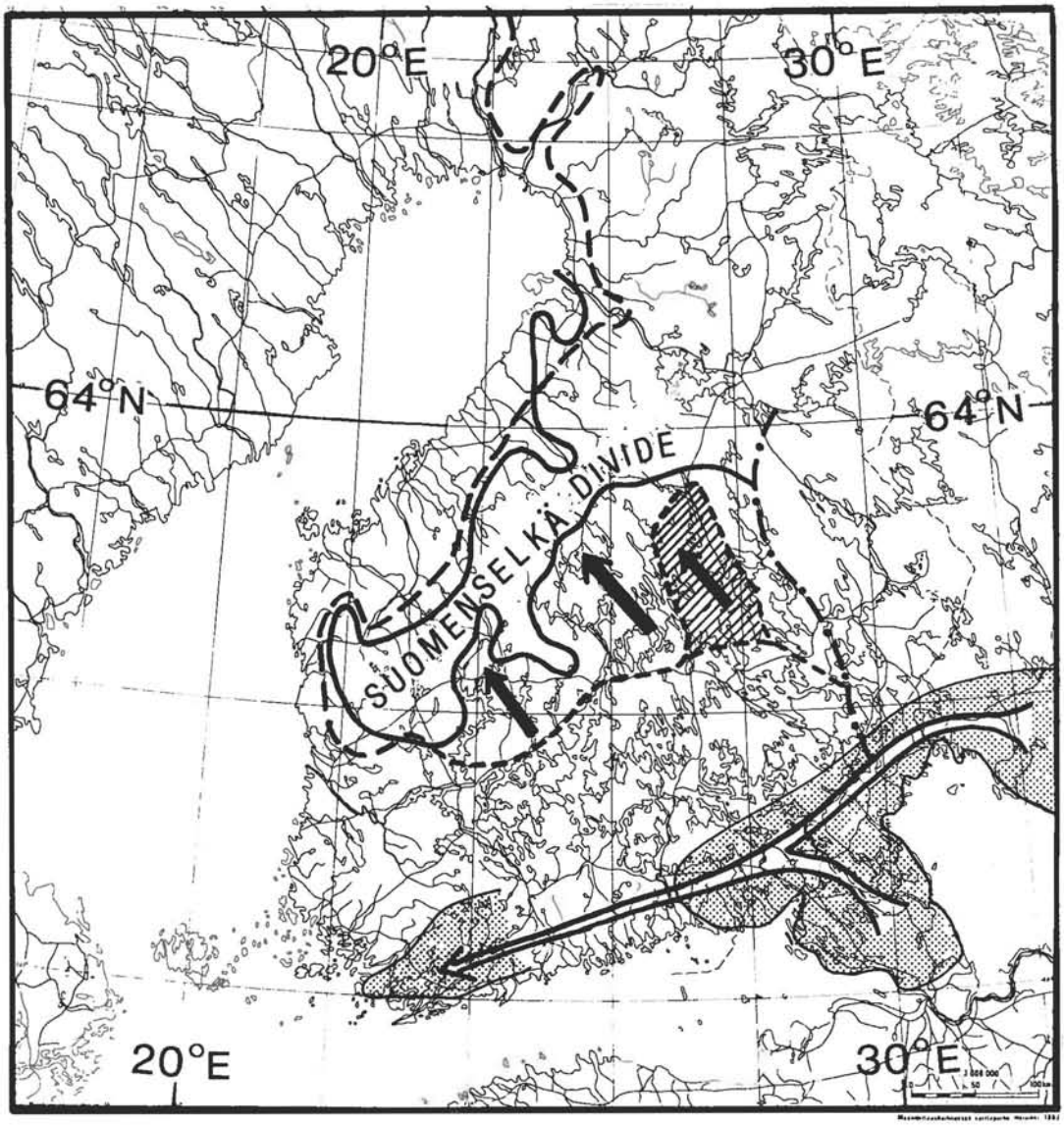


*Fig. 9.* Spread of Karelian settlement in the 15th century to the western parts of the provincce of Uusimaa (white arrow) and the expansion of colonists and settlers from Savo to the north-west in the 15th and 16th centuries (black arrows).
( ▭ ) = Areas of origin and destination of Karelian settlement in Western Uusimaa
( ▨ ) = Area of Savo settlement by the year 1560.
– – – = Northern and eastern boundaries of Finnish settlement in 1560
(Pohjoismaisen autiotilatutkimuksen Suomen jaosto 1973). The boundary of settlement originating in Savo is marked with short dashed lines and that of West Finnish settlement with long dashed lines.
——— = Boundary to the north and east of which the total risk for both arable and burn-beating rye is over 25 %
—•— = Eastern border of Finland (1595).

risks of wintering on the other hand are less than in the northern part of the Lakes Region. The stream of settlement from Savo to the north-west decreased considerably when it reached the border in the watershed regions of the Suomenselkä divide to the north-west of which in most locations the night frost risk for burn-beating rye is over 25 % (Figs. 8 & 9). It was only in places

where this night frost zone was at its narrowest that appreciable numbers of Savo settlers could continue past it to the lake region of Lappajärvi with its lesser risk of night frosts (Figs. 3, 4 & 8).

Settlers from Savo took over the former wilderness hunting areas of the Häme Finns in the valleys of the northern large lakes feeding the Kymijoki River (Fig. 3). These valleys are part of a region extending north from Lake Päijänne where the total risk for the cultivation of rye of the arable variety is only slightly more than that of burn-beating rye, viz. below 25 % (Fig. 8). This made it possible for the Häme settlers to practice rye cultivation alongside the wilderness exploitation economy which was not feasible elsewhere in the northern parts of the Finnish Lakes Region. The boundaries between the areas exploited from Savo on the one hand and Häme on the other were marked out as early as 1446 when inter-tribal disputes were settled (Jalkanen 1892). This border, ratified by Karl Knutsson in 1452, follows to a considerable degree the eastern boundary of the above-mentioned climatic area that was advantageous to the Häme farmers (Fig. 8). Especially during these disputes the wilderness regions may have been of special significance to the settlers of Häme. In the 1430s winters in Europe were especially severe (Lamb 1982), which may also have led to the unsuccessful wintering of rye in Southern Finland. This old boundary was of short duration and was soon crossed by settlers from Savo. When the rapid expansion of settlers from Savo had already ceased the inhabitants of Häme made an effort in 1551 to win back the wilderness regions of the above-mentioned climatic zone (Jalkanen 1892). Also at this stage climatic conditions were especially unfavourable (Lamb 1982); famines were recorded in 1543–1545 and 1551, the latter being the worst (Jussila 1977).

Even in the final stages of its rapid expansion, settlement from Savo extended past the northern boundary of the feed grain zone to the grasses cultivation zone, albeit to parts of the latter that were the most favourable for the growing of rye, the lake region of Kainuu (Huurre & Keränen 1986, Figs. 3, 5 and 8). The rapid increase of population in the 18th and 19th centuries caused settlers to occupy unfavourable locations in the above-mentioned zone where only early barley could be grown successfully. The settlers, used to their former customs, chose their farm sites according to the conditions for growing their own variety of rye. Rye was attempted, although crops could be obtained only in good years. Thus, settlement from Savo occupied the eastern parts of the meadow cultivation zone up to the western part of Kainuu and the Suomenselkä divide (Fig. 4), i.e. to the western boundary of the greater wintering risks and the supra-aquatic hills (Fig. 8). As it was impossible to survive on rye cultivation alone in the meadow cultivation zone, tar-burning became one of the main means of livelihood of the population. In its final stages the tar-burning economy occupied an area (Soininen 1974) corresponding almost completely to that where the total risk for both field and burn-beating varieties of rye is over 25 % (Fig. 10).

With the exception of the southernmost parts of the country, the border of a lesser total risk for arable rye than for the burn-beating variety corresponds to that between the eastern and western dialects of Finnish (Fig. 4, Kotimaisten kielten tutkimuskeskus 1985). This boundary runs north-south mainly in the zone where the wintering risks of arable rye are average (Fig. 6). In the south the border follows the western edge of the above zone and in the north its eastern edge. This is due to the fact that the differences of frost risks for the burn-beating and field varieties of rye increase towards higher risk values, i.e. from south to north.

To the west of the uniform areas of the Savo dialects there is a region favourable to the growing of burn-beating rye due to wintering conditions in turn unfavorable for the growing of avable rye (Figs. 3 & 6). The dialect of this region displays "a definite older influence from Savo" (Kettunen 1930a). Along with data on new settlers (Jokipii 1971, Jokipii et al. 1959, Pohjoismaisen autiotilatutkimuksen Suomen jaosto 1973) this shows that the settlers from Savo had reached their climatic boundaries.

### *Spread of settlement in Southern Finland following the Viking period*

In SW Finland settlement spread from its extent in 1200 (Fig. 2) throughout the bread grain zone in close approximation to the succession of levels of total risk. By the end of the 13th century the area where the total risk for arable rye is less than 10 % was settled throughout (Fig. 7). In medieval times the coastal regions were inhabited from Sweden (e.g. Orrman 1987). The whole of the inland of Southern Finland was however without permanent settlement (Fig. 3). Areas where the total risk for the growing of arable rye is 10–19 % were settled in the 14th century. Areas, in turn, with corresponding risks of

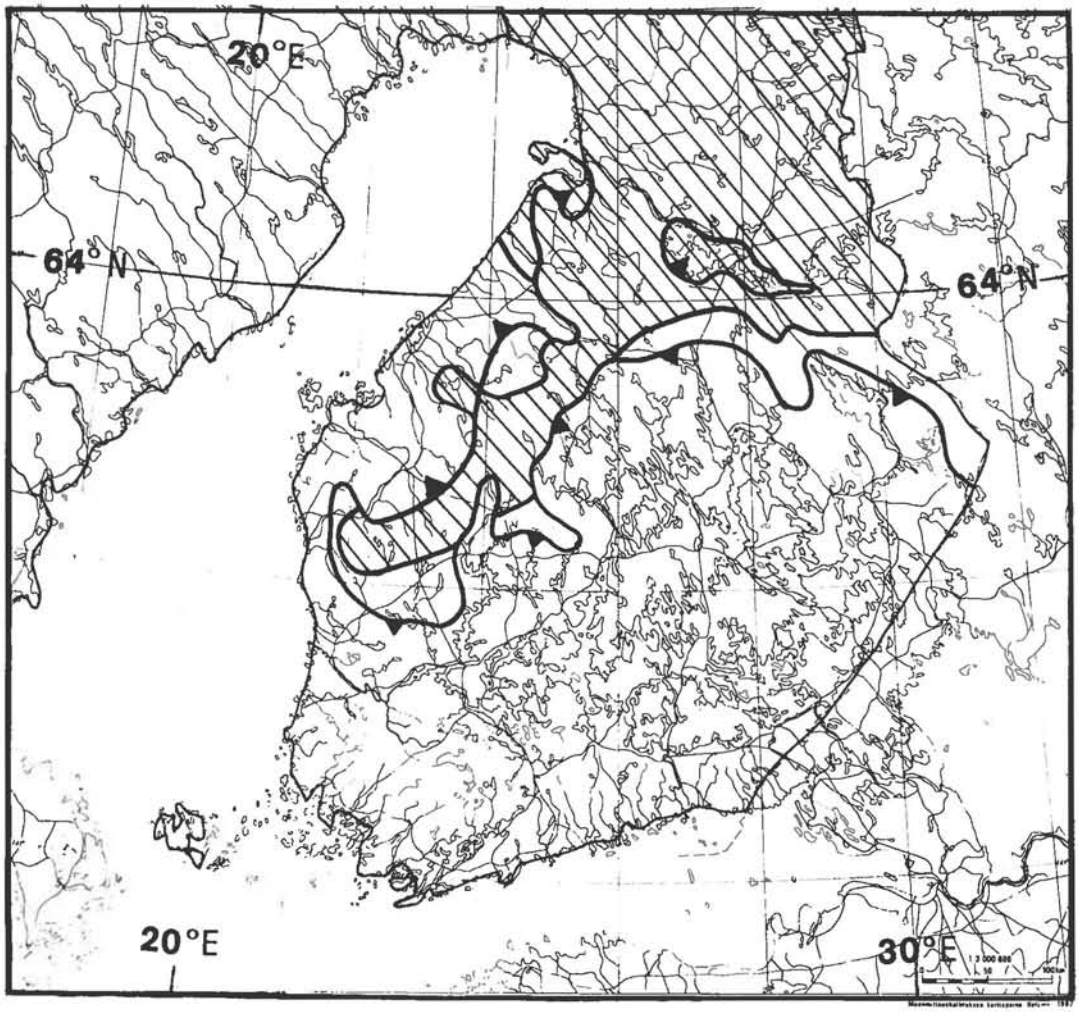


*Fig. 10.* (▲) = Boundary to the north and east of which the total risk for cultivating both arable and burn-beating varieties of rye is over 25 %. The triangles indicate the direction of lesser risk. The hatched area is the sales area of tar in the mid 19th century (Soininen 1974).

over 20 % (Fig. 7) were mainly settled in the 15th and 16th centuries. The north-west boundary regions of the province of Uusimaa, where these risks are greatest (Fig. 8) became permanently settled only as late as the second half of the 18th century (Jussila 1977) – around the same time as settlers from Savo made their way to the Suomenselkä divide and Kainuu where tar-burning instead of rye had to provide a living.

The colonization of the inland regions of Southern Finland was a very slow process in comparison with the spread of settlement in Savo. As the colonists can be seen to have proceeded in orderly succession to areas of increasing total risk for arable rye and West Finnish dialects are spoken as far east as the Kymijoki River (Fig. 3), it could easily be assumed that the areas to the west of the river were originally inhabited solely by speakers of western dialects. The issue, however, is not that simple. The high total risk for arable rye in the inland regions of Southern Finland is mainly a result of the high wintering risk. In the wilderness regions where the total risk for arable rye is over 20 % (Fig. 7), the corresponding total risk for the burn-beating variety is less than 20 %. Thus, the region was suited to burn-beating agriculture of the kind practised in Savo, but was mainly surrounded by SW Finnish or Swedish settlers. Before investigating the

origin of permanent settlement in this region, which was still wilderness in the 14th century, we must discuss the singular methods of cultivation applied there for long periods.

*The adaptation of rye cultivation to conditions in the province of Uusimaa*

As was the case in Savo, Uusimaa was also gradually settled through burn-beating agriculture (Jussila 1977). The burn-beaters cultivated a Western variety of burn-beating rye (Fi. *juuresruis*) which was sown early; Arable rye and barley were also cultivated (Heinricius 1766). Barley was the main grain crop of the burn-beaters (Jussila 1977, Saaristo 1985) and for example in the early 16th century the main grain variety grown in the Greater Lohja region in western Uusimaa (Jussila 1977). Rye began to become more common in the late 16th century and by the 18th century was the main grain species. In the early stages of this course of development barley was more common in Uusimaa than in Finland Proper (SW Finland) or in the Aland Isles. In Uusimaa the proportion of barley cultivation increased towards the west and the north where it was still as common as rye (Ylikangas & Siiriäinen 1973).

The slow spread of settlement, severe years of famine (Jussila 1977) and a preference for barley indicate the difficulties of cultivating rye. This suggests that the wintering properties of the western variety of burn-beating rye were poorer than those of the variety grown in Savo. Some of the properties of the former, its sparse sowing and considerable yield in relation to the amount sown (Heinricius 1766) indicate that it was related to the burn-beating variety of rye (see also Soininen 1974). In time its wintering properties may also have deteriorated.

Soininen (1974) mentions that at least from the 18th century onwards the western burn-beating variety was mixed with arable rye. This was an interesting possibility in so far the former gave a smaller yield per area (Heinricius 1766), which in turn can be explained. The small size of the grains of burn-beating rye (Valle 1931) may also have been a characteristic of the western variety. Arable rye and the western variety became mixed unintentionally through cross-breeding as well.

At any rate, the area of Southern Finland with severe wintering conditions was the only burn-beating area outside the areas with settlement originating from Savo. As late as the 18th century burn-beating was the most common method of cultivation in the areas of highest wintering risk (Soininen 1974), continuing until the 20th century (Jussila 1977). Soininen (1974) correlates the burn-beating areas of Uusimaa with the occurrences of moraine soils. However, moraines are common in all forested areas of Finland. The burn-beating areas of Uusimaa include localities with clayey soils in forested terrain (south of the Salpausselkä ridges) or where stratified soils are exceptionally dominant (e.g. the commune of Hausjärvi). Thus, burn-beating can be specifically linked to climate.

The fact that rye was intended for field cultivation and barley for burn-beating where wintering conditions were severe for the former can also be explained. Paradoxically, this explanation is the same as for wintering damages to rye. In the older South Finnish system of biennial rotation rye was grown every other year and the fields lay fallow in the intervening years (Soininen 1974). The chronology of abandoning this method of cultivation (Soininen 1974) shows that the custom was adhered to most strongly where the winter climate was most adverse to the growing of rye. The custom was last practised in the last burn-beating regions of SW Finland. In these regions, autumn ploughing in the clayey soils is often futile as the ground becomes muddy in late autumn and remains unfrozen under the snow. The soil is not broken up through freezing and the roots of weeds are not damaged. In only this method of cultivation does the field lay fallow as often in summer as in autumn. (In three-part rotation autumn and winter fallow periods which permit weeds to grow occur two years out of three). The growing of the western variety of burn-beating rye and barley in burn-beating plots together with the biennial rotation of rye of the arable variety considerably lessened variations of the total crop.

As late as the 18th and early 19th centuries when arable rye was at its peak of popularity, grain sown in the spring and burn-beating may have provided sufficient nutrition in the north-western parts of the Uusimaa province. For example in 1806, a year when the rye crop failed, barley and oats gave exceptionally good crops which together with wheat amounted to three-quarters of the normal rye crop (Rein 1902).

*Karelian settlers in Uusimaa*

The Swedish settlers remained in the coastal areas mainly because of the fact that the total

risk for growing arable rye was small, though increasing sharply towards the inland regions. The colonization of the inland regions has been explained solely in terms of the spread of SW Finnish settlement both from Häme as well as from the coastal regions of SW Finland. The question arises, whether the burn-beaters of Savo and Karelia could not have come from across the Kymijoki river to occupy the uninhabited areas.

Along the Kymijoki River and to the southwest of it is a long narrow area with a total risk for the growing of arable rye approximately as small as that for the burn-beating variety. This area lies between Savo, on the one hand, and the southern regions of Finland with their difficult winter conditions, on the other (Fig. 6). The area was settled by Häme Finns in the 14th century and formed a barrier to the westward spread of settlement from Savo. A further factor in this configuration was the importance of salmon fishing to the Häme Finns (cf. Rosén 1976). It can be assumed, however, that the Karelians crossed this barrier in the 14th or 15th century making their way into western Uusimaa and the region of Nummi-Pusula before the SW Finns. Three grounds can be presented for this conclusion.

First of all, the properties of the western variety of burn-beating rye grown by the burn-beaters in Uusimaa in the 18th century were very close to those of the burn-beating variety of rye. Secondly, the dialect term for the container for the sowing seed and its distribution also indicates the actual movements of its users. According to Länsimäki (1987) the eastern dialects of Finnish use only the form "kylvyvakka" of the sowing receptacle. Western Uusimaa forms, however, a separate pocket in the area of the West Finnish dialects where the Savo-Karelian form "kylvyvakka" is used alongside "kylvinvakka" of West Finnish origin (ibid.). The area of occurrence of the term "kylvyvakka" in Western Uusimaa corresponds exactly to the 18th century burn-beating region as according to Soininen (1974). In Eastern Uusimaa the term "kylvakka", obviously an abbreviation of "kylvyvakka" and used alongside "kylvinvakka" appears to form a bridge between the West Uusimaa and Karelian uses of the term "kylvyvakka". The dialects of Uusimaa display contacts between elements from Häme, SW Finland as well as old Karelian elements (Kettunen 1930b). Kettunen has even found features distinctive of the Karelian language in the dialects of Uusimaa.

Most of the earliest male surnames of the Nummi-Pusula region in Western Uusimaa mentioned by Jussila (1977) have one feature in common. They also occur in Southern Karelia in the 16th century (Fig. 9) in lists of names compiled by Mikkonen and Paikkala (1984). The oldest place-names of Uusimaa can also be found in Karelia as far east as Lake Onega.

*The spread of West Finnish settlement in Häme, Satakunta and Ostrobothnia.*

Settlement from Satakunta and Häme spread to the east and north from the original Late Iron Age centres. The spread of settlement followed the geographical order of increasing risk for the cultivation of the arable variety of rye. By the mid-16th century settlement from Western Finland bordered on that from Savo in locations where the total risks for the growing of both varieties of rye were the same. In the north settlement bordered on the northern boundary of the bread grain zone (Fig. 2) and the Suomenselkä divide with its high risks of night frosts (Fig. 3 & 5) and where neither the wilderness nor the field varieties of rye thrived (Fig. 8). The area was mainly settled as late as the 18th century and formed the southern part of the youngest tar-burning area (Fig. 10). Throughout the history of Finland the southern part of the Suomenselkä divide has kept the settlers of Ostrobothnia apart from the rest of Western Finland, leading to differences in folk culture (see e.g. Luukko 1950).

From Southern Ostrobothnia (Fig. 3), which was re-inhabited, settlers spread to the surrounding feed grain zone mainly practising field cultivation and from the 16th or 17th centuries onwards the cultivation of reclaimed bogs (Soininen 1974). Wintering risks for rye which favour slash-and-burn cultivation methods increase sharply towards the inland regions. As the risks of night frosts also increase towards the inland regions, settlement spread to the north along the coast (Fig. 9). With the growth of population the Ostrobothnians, like the inhabitants of Savo, also occupied the less advantageous parts of the feed grain zone (Figs. 3, 4 and 8) and mainly in the late 18th and early 19th centuries moved on to the grasses cultivation zone (Figs. 4 & 8). In these areas a rye-growing economy was not feasible and resource had to be made to tar-burning (Fig. 10).

## THE RATE OF THE SPREAD OF SETTLEMENT TOWARDS POORER CLIMATIC AREAS

The spread of SW Finnish settlers in the southernmost inland regions and the movement of the Savo Finns through the northern parts of the Lakes Region were in a sense equally rapid phenomena. In the former case settlement spread in streams from the edges of an oval area towards the centre with its poorer conditions so that each generation of settlers had on the average an extra year of poor crops to contend with. This in turn increased the pace of new settlement. The same average crop or yield required a larger field or burn-beating plot and there were fewer and fewer field or burn-beating sites of small risk.

Climatic conditions throughout nearly all of the southern Lakes Region (Fig. 4) are favourable for the growing of rye. In the northern parts of the Lakes Region, however, favourable sites occur only as bands running from north to south in the valleys of lakes or as sporadic patches of higher land in areas with night frosts. Although the spread of settlement in kilometres per generation was different from that in Southern Finland, the overall progression towards areas with increasing risks of cultivation was approximately the same as in the south. The following generation also had an extra year of crop failure to bear.

The effect of climatic risks on the choice of grain varieties cultivated and the variability of their crops may also have had an effect on the culture of brewed beverages. The fact that the SW Finnish areas of new settlement had to rely to a great extent on barley may have some effect on the longevity of the local brewing of ales and beer in these regions.

## ON THE SAVO FINNS IN SWEDEN

Because of the culture of rye cultivation the Swedes encountered in principle similar problems in colonizing wilderness areas as the farmers of SW Finland. In practice, however, the difficulties of the Swedes were not as considerable. Due to its cold and short periods of growth, the wide inland regions of Northern Sweden mainly remained outside the area of rye cultivation regardless of variety. On the other hand, the mild winters of Southern Sweden provided good wintering conditions for rye. Areas unfavourable for the growing of rye of the Scandinavian arable variety, similar to the burn-beating regions of Finland and forming a barrier to the spread of settlement, extended from eastern Hedmark in Norway through the northern parts of Vermland to the upland regions around Lake Siljan in Dalecarlia and from there to Gästrikland and Hälsingland. The Swedish authorities were apprised of the abilities of the Savo Finns as pioneers and settlers (e.g. Vilkuna 1953) and they began to promote the colonization of wilderness regions of Sweden by them. The settlements of the Savo Finns in the so-called Finn forests of Sweden and Norway (Salminen 1909, Fig. 11) fulfilled the same function in the same climatic conditions of growth and wintering as those in Finland. These settlements also succeeded in preserving a pure variety of burn-beating rye (see Valle 1931) until the present century.

## DISCUSSION

On the applicability of regional features of present climate in the climatic interpretation of the rye growing period.

In the present bread grain zone of Finland the regional risks of severe night frosts in the growing season are determined mainly by the presence of bodies of water and the elevation of the terrain (Solantie 1987). These regional differences are more or less independent of the climatic variations of the mean summer temperature. Only with the possible advent of summers so warm that the risk of severe night frosts would diminish throughout the present bread grain zone of Finland, could the regional differences (see Fig. 5) disappear. This would bring about a growing season so warm and long that it would be seen in the natural flora of Finland in a way contradictory to palaeontological and historical data. The regional differences in the thickness of the snow cover, important for the wintering of rye, is in turn dictated by temperature, precipitation and prevailing winds as well as the elevation of the terrain in question and its distance from the sea.

In our present climate air currents from between the south and the west predominate in winter and most of the snowfall comes in front of low pressure areas with winds ranging from the south-west to the east. In so far as the climate resembles that of former times, the regional differences of winter temperatures, pre-

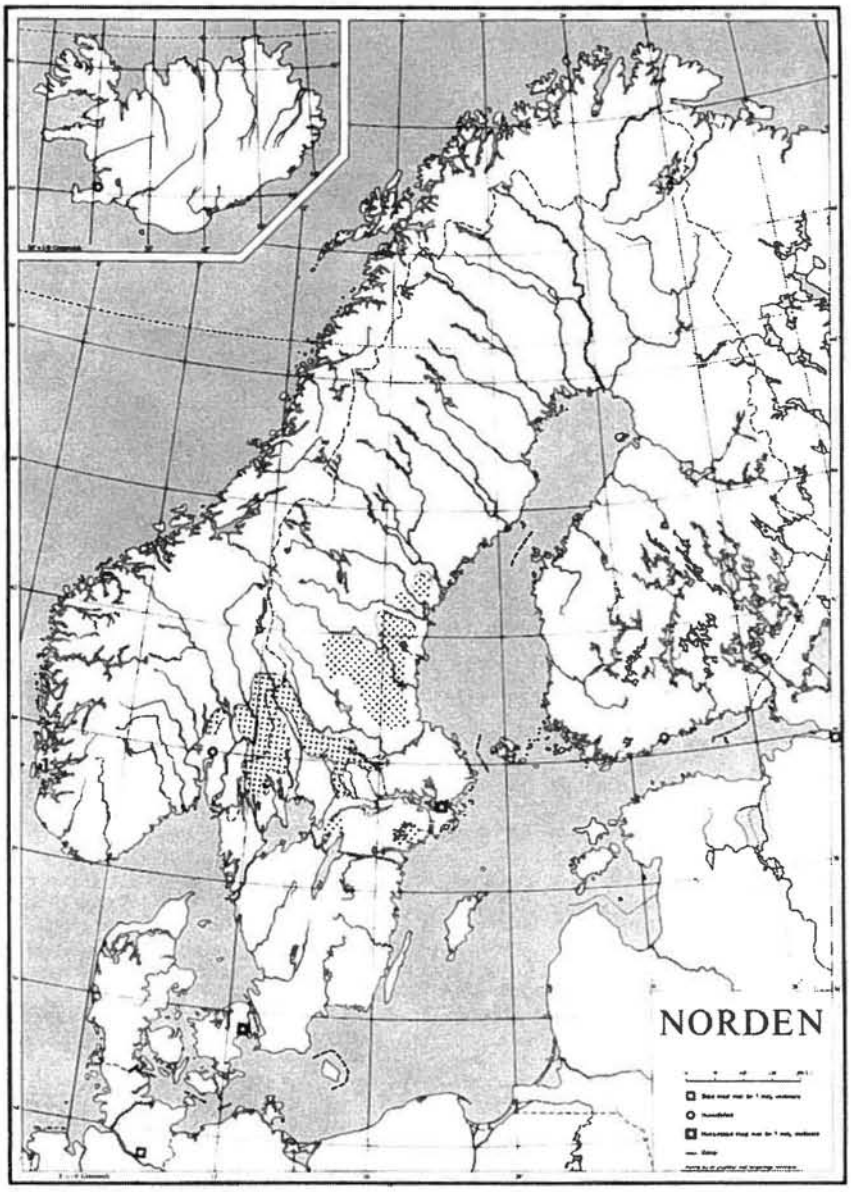


*Fig. 11.* Regions settled and farmed by Finns in Central Scandinavia. Re-drawn by the author according to an original map by Salminen (1909).

cipitation and the mean snow depth were then the same as today. The same also applies to regional differences in the wintering of rye. This means that relative differences between regions will remain despite even considerable changes in mean temperature, precipitation and snow depth throughout Southern Finland. The location of shorelines and the formation of the terrain, which in winter account for regional differences, remain practically unchanged.

The wintering risks for rye and the geographical distribution of the related climatic parameters would change appreciably in only two cases. The first possibility is that solid precipitation would be so insignificant and the winter so mild that there would be no permanent snow

cover. The regional distribution of the snow cover would also differ from the present in a winter climate with low pressure areas moving east solely over Central Europe, thus accounting for a significantly different winter climate. This would bring about snows in Southern Finland mainly with winds ranging from the north-west to the east, which at present is not the case even in the northernmost parts of Lapland. Consequently, the winters would be severely cold.

In summary, it can be noted that a differing regional pattern of snow depth at any stage after the beginning of the present era would require climatic changes of a magnitude not encountered in the climatic history of Europe.

## REFERENCES


Eronen, M., 1974. The history of the Litorina Sea and associated holocene events. *Comm. Phys.-Math.* 44, 79–195.

Heinricius, J., 1766. Beskrifning öfwer Stor Lojo Socken i Nyland. *Bidrag till Lojo sockenbeskrivning* 1. Helsinki 1895.

Huurre, Matti, 1979. *9000 vuotta Suomen esihistoriaa.* Helsinki.

Huurre, M & Keränen, J., 1986. *Kainuun historia* I. Kajaani.

Jalkanen, K.J., 1892. *Pohjois-Hämeen Erämaat, Asutus ja Olot vuoteen 1620.* Hämeenlinna.

Jokipii, M., 1971. Parkanon ja Kihniön synty. *Parkanon ja Kihniön kirja,* 37–96.

Jokipii, M. & al., 1959. *Vanhan Ruoveden historia* I. Vammala.

Jussila, O., 1977. *Nummen historia.* Vammala.

Kettunen, L., 1930a. Suomen murteet I. Murrenäytteitä. *Suomalaisen kirjallisuuden seuran toimituksia,* 188. osa, 294 pp.

Kettunen, L., 1930b. Suomen murteet II. Murrealueet. *Suomalaisen kirjallisuuden seuran toimituksia,* 188. osa, 209 pp.

Kotimaisten kielten tutkimuskeskus 1985, Suomen murteiden sanakirja. Ensimmäinen osa a–elää. *Kotimaisten kielten tutkimuskeskuksen julkaisuja* 36.

Kurki, M., 1982. *Suomen peltojen viljavuudesta* III.

Lamb, H., 1982. *Climate history and the modern world.* London and New York.

Luukko, A., 1950. Keskiaika ja 1500-luku. *Etelä-Pohjanmaan historia* II. Helsinki.

Länsimäki, M. 1987. *Suomen verbikantaiset in:ime -johdokset.* Helsinki.

Miettinen, M. & Vuorela, I. 1988. Archaeological and palynological studies of the agricultural history of Vörå and Malax, Southern Ostrobothnia. *Fennoscandia archaeologica* V.

Mikkonen, P. & Paikkala, S. 1984. *Suomen kielen sanakirja* IV. Suomalainen nimikirja, sukunimet.

Mukula, J., 1981. Suomen historian suuret katovuodet. *Forssan lehti* 31.10.28.

Mukula, J & Rantanen, O., 1987. Climatic risks to the yield and quality of field crops in Finland. 1. Basic facts about Finnish field crops production. *Annales agriculturae Fenniae,* Vol 26, *Seria agricultura* N. 82, 1–18.

Nunez, M. & Vuorela, I. 1976. A field method for the retrieval of plant remains from archeaological sites. *Memoranda Soc. Fauna Flora Fennica* 52, 19–22.

Orrman, E., 1987. Om geologiska faktorers inverkan på bebyggelsen i södra Finland mot slutet av järnåldern och under tidig medeltid. *Historisk Tidskrift för Finland* 2/1987, 169–188.

Pohjoismaisen autiotilatutkimuksen Suomen jaosto, 1973. Suomen asutus 1560-luvulla. Kartasto. *Suomen historiallinen seura. Käsikirjoja* VII. Forssa.

Rantanen, O., 1979. Rukiin kylvöaika Etelä-Suomessa. *Koetoiminta ja käytäntö* 10.7.1979.

Rantanen, O. & Solantie, R., 1987. Climatic risks to the yield and quality of field crops in Finland II. Cultivation zones and sub-division. *Ann. Agric. Fenn.* 26, p. 19–37.

Rein, K., 1902. Det forna Stor-Lojo. En landtbruksstatistisk studie. *Bidrag till Lojo Sockenbesskrivning.* Helsinki.

Rosén, R., 1936. *Vehkalahden pitäjän historia* I. Helsinki.

Saaristo, M., 1985. *Pukkilan historia.* Järvenpää.

Salminen, V., 1909. Skandinavian metsäsuomalaisten vaiheet. *Kansalaiskirjasto* 7.

Soininen, A., 1961. Pohjois-Savon asuttaminen keski- ja uuden ajan vaihteessa. *Historiallisia tutkimuksia* 58.

Soininen, A., 1974. Vanha maataloutemme. Maatalous ja maatalousväestö Suomessa perinnäisen maatalouden loppukaudella 1720-luvulta 1870-luvulle. *Journal of the scientific agricultural society of Finland.* Vol. 46. 1974. Supplement.

Solantie, R., 1978. On the variation of snow depth on 15th March in Finland. *Nordic hydrological conference and Second Nordic IHP Meeting Hanasaari Cultural Centre, July 31–August 3, 1978.* The Nordic Association for Hydrology, the Nordic National IHP Committees and the National Board of Waters in Finland.

Solantie, R., 1985. Viljelykasvien ilmastollisten talvehtimisriskien aluellisuudesta Suomessa. *Maatal. hall. Aikakausk.* 4, 21–26.

Solantie, R., 1987. Hallojen loppuminen keväällä ja alkaminen syksyllä. *Meteorologisia julkaisuja* No 6 1987.

Tolonen, M., 1978. Palaeoecology of annually laminated sediments in lake Ahvenainen, S. Finland I Pollen and charcoal analyses and their relation to human impact. *Annales botanici Fennici* 15:3, 177–208.

Valle, O., 1931. Erään suomalaisen kaskiruiskannan historiaa. *Pellervo* No 6/1931, 118–121.

Vilkuna, K., 1953. Varpå beror den finske svedjebondens kolonisationsförmåga. *Värmland förr och nu,* 9–20.

Vilkuna, K., 1960. Savolaiset erämaan valloittajina. *Kotiseutu* 3/1960, 47–53.

Vuorela, I., 1975. Pollenanalysis as a means of a tracing settlement history in SW-Finland. *Acta Botanica Fennica* 104.

Vuorela, I., 1986. Cultural palaeoecology in Malax, southern Ostrobothnia. Pollen analysis. *Striae* 24, 165–168.

Vuorela, I., & Lempiäinen, T., 1988. Archaeobotany of the site of the oldest cereal grain find in Finland. *Annales Botanici Fennici* 25, 34–45.

Ylikangas, H & Siiriäinen A., 1973. *Lohjalaisten historia.* Helsinki.