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Geografisk Tidsskrift, Bind 58 (1959)

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## **Utilization of Arable Land on Outwash Plain and Moraine Landscape in Denmark.**

By Aa. H. Kampp.

Danish agriculture as a whole attaches the greatest importance to intensive cattle breeding. For this reason, the cereals have at present a far less predominant situation in Danish farming than in most other countries, and the grain areas cover less than half of the arable land. The remaining part is covered with grass, green fodder and roots.

The arable land is intensively utilized. One of the results of this is that the system of fallow has been abandoned. As a rule, the crops in one field alternate in a fixed succession. If all the fields are of equal size the farmer will have the same area of each crop every year. Manure is added, and a greater profit is drawn from the nutrient by changing the crops from year to year in order not to exhaust the soil by using always the same crops and, consequently, the same set of nutrient in one field. At least once in the rotation, in the root field, weeding is done, and in the grain-field the weed is chemically destroyed. In this manner the soil keeps its fertility, the farm-work is dispersed as evenly as possible, and parasites do not become predominant.

### **Field-rotation systems in Denmark.**

On the basis of a series of inquiries, a representative investigation has been made dealing with the field rotation in different regions of Denmark (Kampp, 1956 b). The 8-field rotation is the most common in the greater part of Denmark, corresponding to the utilization for the whole country: barley, oats, mixed grain, rye or wheat, grass, and roots, each of the two lastmentioned often

being cultivated in two fields, or seed crops may be grown. The 7-field rotation is common where only one field is grown with root crops, especially in Vendsyssel, while the 6-field rotation seems to be predominant in North-West Jutland with its bullock-feeding farms, where seed crops are very rare. If kohlrabi (swedes) is a fixed link in the field rotation 7—8 years seem to be the smallest possible distance considering the *Plasmodiophora brassicae*. The same rule holds good for clover and oats (*Tylenchus*), wheat and barley (*Fusarium*).

Examples are given from 11 to 5 field rotation; however, the whole problem is complicated by the "camouflaged" rotation, for example this one: 1. wheat; 2. a. sugar beet; 2. b. kohlrabi; 3. a. barley; 3. b. oats; 4. grass; 5. grass, where, in reality, 2 and 3 are grown as 4 different fields. As to oats, barley, kohlrabi and sugar beets it is a question of a 10-year rotation, though called a 5-field rotation.

The character of the field rotation is usually inherent with the wish of being able to provide fodder for the live-stock and, therefore, the system may vary in accordance with the number of stock. In the few farms in Denmark where agriculture is stockless and, consequently, without roots or grass, the number of fields may, of course, be reduced. This may be the case too where meadows render rotation-grass superfluous. The number of rotation-fields may also change according to the fluctuations of the market for seed crops, permanent grass or lucerne. However, the number seems neither to depend upon the fertility of soil (except where large meadow-areas and marsh-areas exist) nor on the situation in relation to towns (apart from Copenhagen), as vegetables and fruits are principally grown in special farms (Kampp 1952). Other cash crops, as outdoor vegetables on ordinary farms, are grown, according to the owners' interests, regardless of the town distance, because the increase of the rate price for long carriage is compensated by the lower price of the land and, partly, of the labour.

However, the number of rotation fields is only a frame within which it is possible to vary the system a good deal in conformity with the fertility of the soil, the capability of the farmer and the prices of different farming products. In some regions there are 2 or 3 different rotation systems at the same farm, as a rule in order to make it possible always to have roots or grass near the stables, so as to ensure an easy contribution of roots to the cows and the bullocks in the stable. Further, this rotation system allows to pro-

vide the small calves grazing in the field with milk, which it would be difficult to transport over a long distance, and to take them to the stable when the weather is cold or rainy. The application of more than one rotation system may also be due to pronounced differences in the soil fertility of the farm-land. However, owing to the mechanization, there is a tendency, for the whole country, towards an adoption of the largest possible fields. "Free rotation" is used, for instance, to grow roots in fields with much weed and, especially, to be able to grow the seed crop which obtains the most advantageous price at the market.

On the outwash plains in Western Jutland the use of the rotation fields (but hardly their number) may be fixed according to meadows and other natural pastures outside the rotation. The West Jutland farmers, however, not rarely overestimate the benefit which may be drawn from these sour meadows, often situated at a long distance, and from where one may get, rather labouriously, a few cart-loads of second-class hay, or where the heifers may graze during three or four summer months.

#### Two examples of field rotation.

Below are given two examples of the utilization of arable land in Denmark, the first one from agricultural region I, the second one from region VII (fig. 1, Kampp 1959). The two examples have been chosen from the ordnance survey maps M 2905 and M 3101 as typical of farms situated 1) on outwash plain transformed into farm-land (with rather poor soil fertility) and 2) on moraine landscape with the most favourable conditions for cultivation.

The two farms are *Overgård* on an outwash plain in Western Jutland and *Grønvang* on the fertile, undulating East Jutland moraine landscape, some few kilometres east of the main ice margin from the last Ice Age (Würm). In fig. 1 *Overgård* is marked O and *Grønvang* G, on a map showing the 7 agricultural regions of Denmark. This map is based on the yield capacity of the soils, as explained in a previous paper (Kampp 1959).

Each of the seven regions has a peculiar combination of crops and livestock. Characteristic features of the farming area are in region I: Mixed grain, rye, and potatoes; in II: grass, oats, rye, and bullocks; in III: oats, barley, and mixed grain; in IV: mixed grain, rye, oats, and potatoes; in V: barley, oats, wheat, rye, potatoes, and orchards; in VI: barley, oats, wheat, and bullocks; in VII:

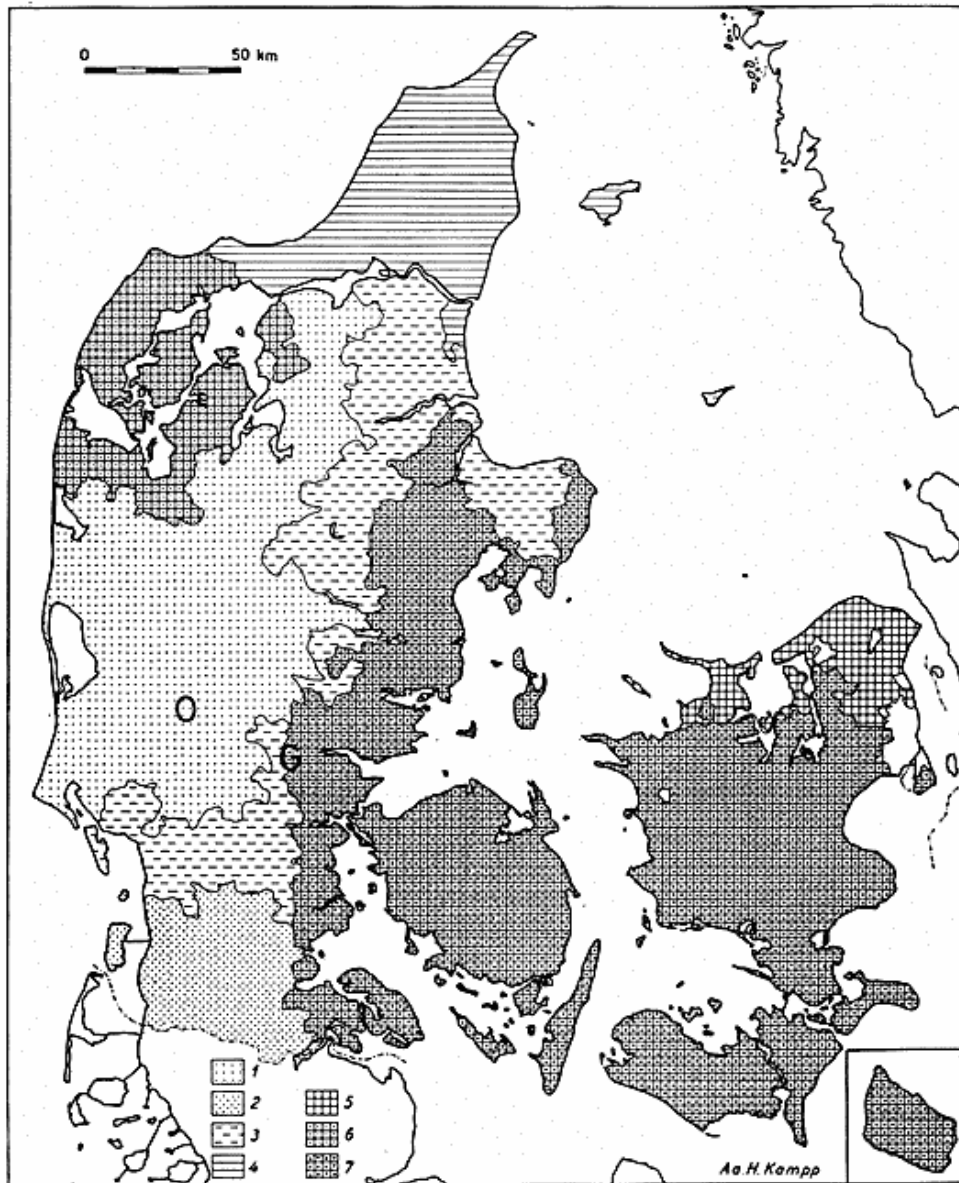


Fig. 1. Agricultural Regions of Denmark.

barley, wheat, and beets, five sixths of the seed-producing area of the whole country, and a large part of the nursery garden and orchard areas. The yields per unit of area are low in regions I and II, medium in III and IV, fairly high in V, and high in VI and VII. With the exception of region II, where the density of live-stock is smallest, it generally increases in the regions in the order mentioned above. As for the breed of cattle, Shorthorns dominate in II and VI, Shorthorns and Black and White Danish Dairy Cattle (SDM) in I, SDM in IV, Red Danish Dairy Cattle (RDM) in V and VII.

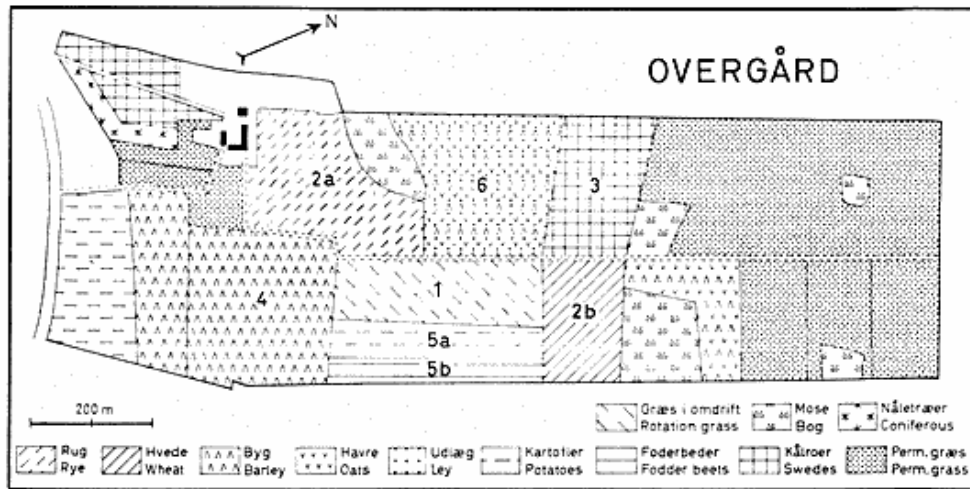


Fig. 2. The field rotation plan of Overgård on the outwash plain, Ringkøbing county.

Region III is a rather peculiar area with various breeds. The yield of butter per cow is much less in the regions I, III, and IV than in the regions V, VI, and VII.

Fig. 2 shows the field-plan of *Overgård*, Ørbæk village, Hoven parish, Nørre Horne district, *Ringkøbing county*. The land-register numbers are 3a and 4a with a total of 65,7 hectares (apart from road areas). The farm has been on copyhold till about 1800; however, it has only belonged to the owner's family since 1927. The present buildings are from 1900 (the eastern wing was rebuilt in 1933, the northern one in 1942).

The depth of the soil varies from 25 to 40 cm. In the southernmost fields (inclusive of 2a and 4) the soil consists of podsolized sand with an extremely low content of humus; the subsoil is leached sand. The remaining fields have a blackmoulded, sandy soil, originating from outwash sand with superposed, swamped bog. Peat has been dug until recently in the bogs and is at present (1959) dug in the north-eastern one. Next year this area will be tilled. The 4 permanent grass fields to the north were raw humus until 1935. The adjacent parts of the kohlrabi fields and of the mixed-grain fields is land which was reclaimed in 1931. The last-mentioned field will from next year be permanent grass.

The 6-field rotation only includes the numbered fields and runs as follows: 1: grass for hay; 2: grain (the species depending upon the soil humidity and acid reaction); 3: kohlrabi; 4: grain (as 2); 5: beet and potatoes (depending upon the soil); 6: grain with ley. The permanent grass fields which lie untouched for at least 10

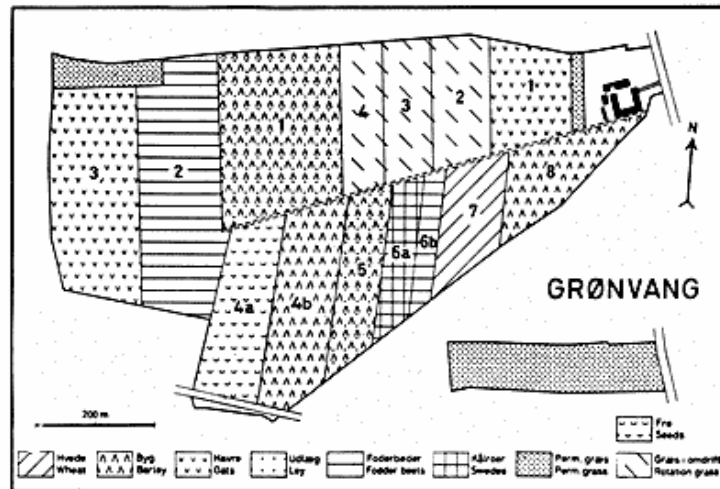


Fig. 3. The field rotation plan of Grønvang on the young morain landscape, Vejle county.

years have all been fenced in for grazing, except the small one east of the stable, which has been mowed for the pigs; the other two small ones are used for the calves. All other fields are without any hard and firm rotation; the farmer only changes between a grain species and a root crop. The fields south of the garden bear evidence of having been, years ago, under the meadow irrigation system of the water course Omme Å.

In 1958 the barley yielded (as normally) 35 hkg. per hectare, oats 20 (one field gave 0, the oats being used for grazing because of an infection with crane fly larvae). Owing to this parasite, rye has not been grown for 10 years. Wheat has not been grown until this year.

**Livestock:** 26 dairy cows (SDM breed, artificial insemination is used), 35 young stock, 4 sows with 11 suckling pigs (June 1959), 70 bacon pigs, 50 hens. The yield of butter per cow per year has varied, during the last five years, from 141 kg. to 185 kg.

**Implements:** 1 tractor with plough, harrows, potato-planter, potato-lifter, horseshoe, drill, reaping machine and a binder. Milking-machine is used.

**Staff:** 1 farm hand all the year round, 2 in the summer; the farmer's wife gives a hand in weeding the beets, harvesting grain and potatoes.

Fig. 3 is a field-plan for *Grønvang* 1959. The larger part of the farm-land, immediately at the farm, has land-register no. 5a in Balle village, Bredsten parish, Tørrild district, *Vejle county*. Apart from roads, it amounts to 43,9 hectares. The rectangular area south

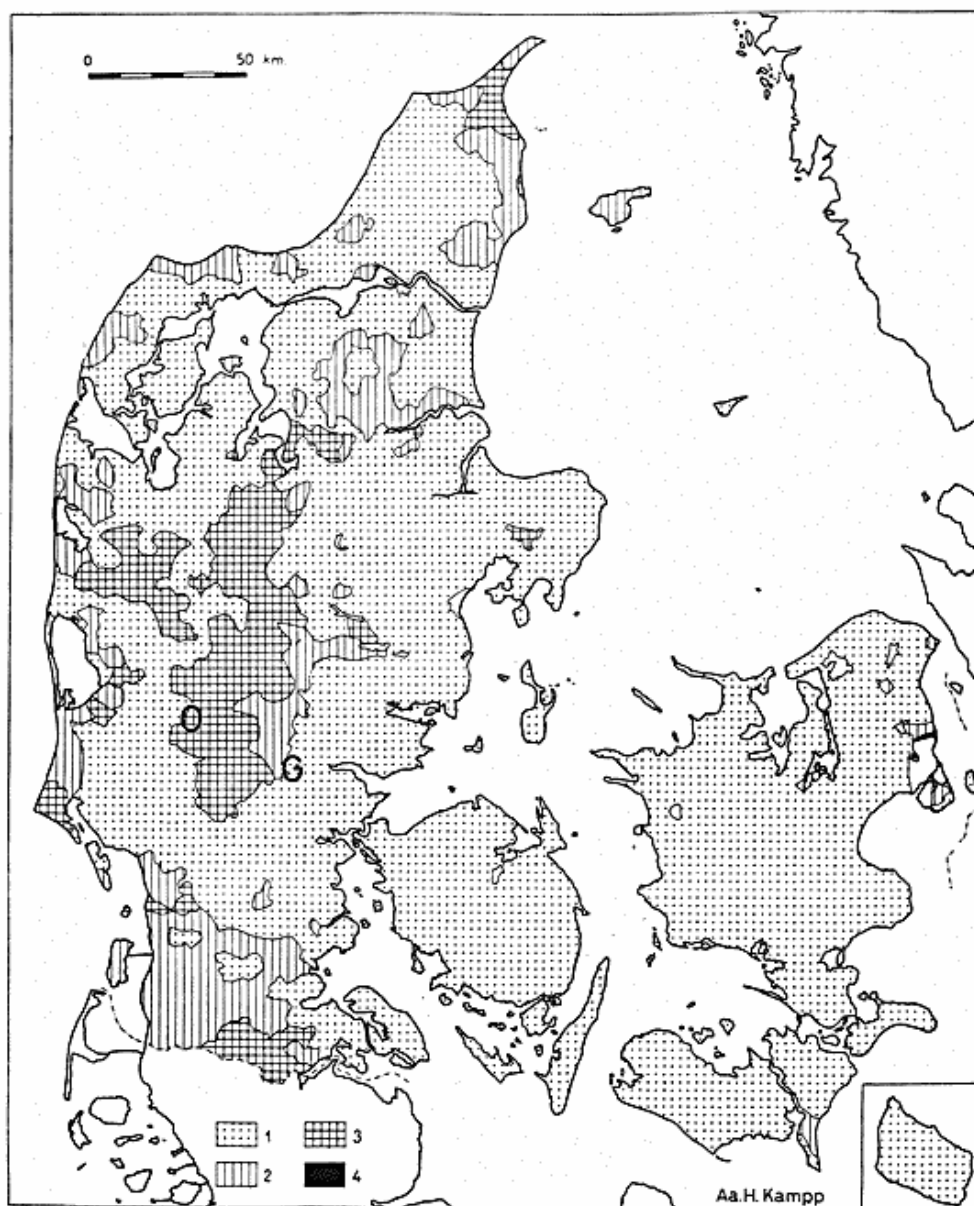


Fig. 4. The principal cereal by area (1951) in each Danish parish: 1. two-rowed barley; 2. oats; 3. rye, and 4. wheat.

of Bredsten (land-register no. 4b, 2,9 hectares) was bought at the occasion of the parcelling-out of Bredstensgårde in 1937. A small area, land-register no. 7c, about 3 km. south of the farm, amounts to 0,6 hectares with calcareous tufas and is, consequently, not taken into consideration in this paper. The area south of the East-West going road is let; two houses have been constructed. This gives a total agricultural area of 46,2 hectares. The farm was taken over on copyhold from the estate Engelsholm by the present owner's



family more than 200 years ago and was bought free about 160 years ago. The buildings are from 1890—96; however, they were enlarged and modernized in 1930—31.

*The soil* is a clay mull of varying depth (about 45 cm. nearest to the farm and decreasing to the west to 20 cm.). Subsoil of sandy clay forms a 0—50 m. broad belt along the northern boundary. In the remaining part of the area the subsoil is boulder clay, except in a few small, former bog depressions, distributed over the land, with peat as subsoil. In field 1 (barley) and partly in 4, immediately north of the field-path, an accretion bog, amounting to 1 hectare, has now been totally reclaimed.

Besides the three *permanent grass* plots, which have been fenced and are used for grazing, there are *two rotation systems*. The fields nearest to the farm buildings, numbered 1—8, are principally used for grazing. A 4th-year grass bed has been used till now. Field no. 2 has 3rd-year grass, no. 3 2nd-year and no. 4 1st-year grass. The ley in no. 5 is for 3 year old grass. The sugar beet is for fodder only. The ley in no. 8 is orchard grass (*dactylus glomerata*) and red clover, planned for one year only. The farmer will alter this rotation; in 1960 it will run as follows: 1: 1st-year grass (orchard grass + red clover); 2: barley with ley (as 1); 3: oats; 4: 3rd-year grass; 5: 2nd-year grass; 6: 1st-year grass; 7: roots; 8: barley with ley (as 1).

The other rotation system consists of 4 fields. There is no fixed rotation; however, common practice, being the result of a long-time experience in the preparation of the fields, is used from one year to another. The ley in the barley is white clover, red clover and Italian rye-grass for seed; the sugar beets are exclusively used for fodder. Half of field no. 4 is covered with Italian rye-grass for seed, the other half with barley, just as in 1958. According to the original plan it ought to have been white and red clover for seed; however, owing to trade depression, these crops were not sown. The seed areas are interchanged, so that in the next turn, 1963, 4a will carry clover, and, in its turn, red and white clover will be interchanged in 1967. This arrangement involves for each field an interval of 8 years between two crops of Italian rye-grass and 16 years between two crops of red clover etc. The yields were in 1958: barley 40 hkg. per hectare; oats 36; no wheat. Normally the yields are: barley 50—52, oats 48—50, wheat 52—54.

*Livestock*: 2 brood mares, 34 dairy cows (RDM breed), sometimes 1 bull; however, as a rule artificial insemination is used;

35 young stock, 20 sows with 70 suckling pigs (June 1959), 100 bacon pigs and 200 hens. The yield of butter per cow per year has varied, during the last five years, from 191,2 kg. to 225 kg.

*Implements:* 1 tractor with plough, harrows, horsehoe, fluid-sprayer and harvesting implements. The farm is equipped with milking-machine.

*Staff:* 1 married cattle-man, 1 married farm-hand, 1 younger farm-hand, 2 in the summer.

Likewise, nearly all the neighbouring farmers are working with rather large live-stock and, accordingly, have 1—2 fields with beet and rather large grass areas.

Some of the most obvious differences between the two farms are that potatoes, mixed grain, and rye are only grown on the podsolized sand at Overgård (O), while seed crops are only grown on the fertile clay at Grønvang (G). G. has a larger area of rotation-grass, beet and kohlrabi than O. Consequently, it is not surprising to find that O. has only 84,5 live-stock units in spite of its 66 hectares (1,3 per hectare), while G. has 149 units on 46 hectares (3,2 per hectare) and consequently, a larger staff. The two different cattle breeds are also characteristic of the respective regions. The average yield of butter per cow per year is on O.: 173 kg.; on G.: 201,2 kg.

#### **The utilization illustrated by crop predominance maps.**

How typical the crops on the two farms are of the respective regions appears from fig. 4 and fig. 5: O. is situated in the rye/potato-region, G. in the barley/kohlrabi-region. Fig. 4 indicates the principal cereal by area in 1951 in each Danish parish: 1. two-rowed barley; 2: oats; 3: rye, and 4: wheat. About 200 detailed agricultural maps exist at the Geographical Institute of the University of Copenhagen. A few examples have been published (Kampp 1939, 1952, 1956 and 1959).

The two-rowed barley covered in 1951 a bigger area than any other cereal in most of the parishes of Denmark, especially the islands and the eastern part of Jutland. As Denmark is situated in the oat-region of North-West Europe oats was predominant in the first part of the century in Jutland with the exception of the rye-regions, which were especially found in the moist South-West Jutland and more northern outwash plains and other sandy soils; however, because of the higher yields and the higher prices of

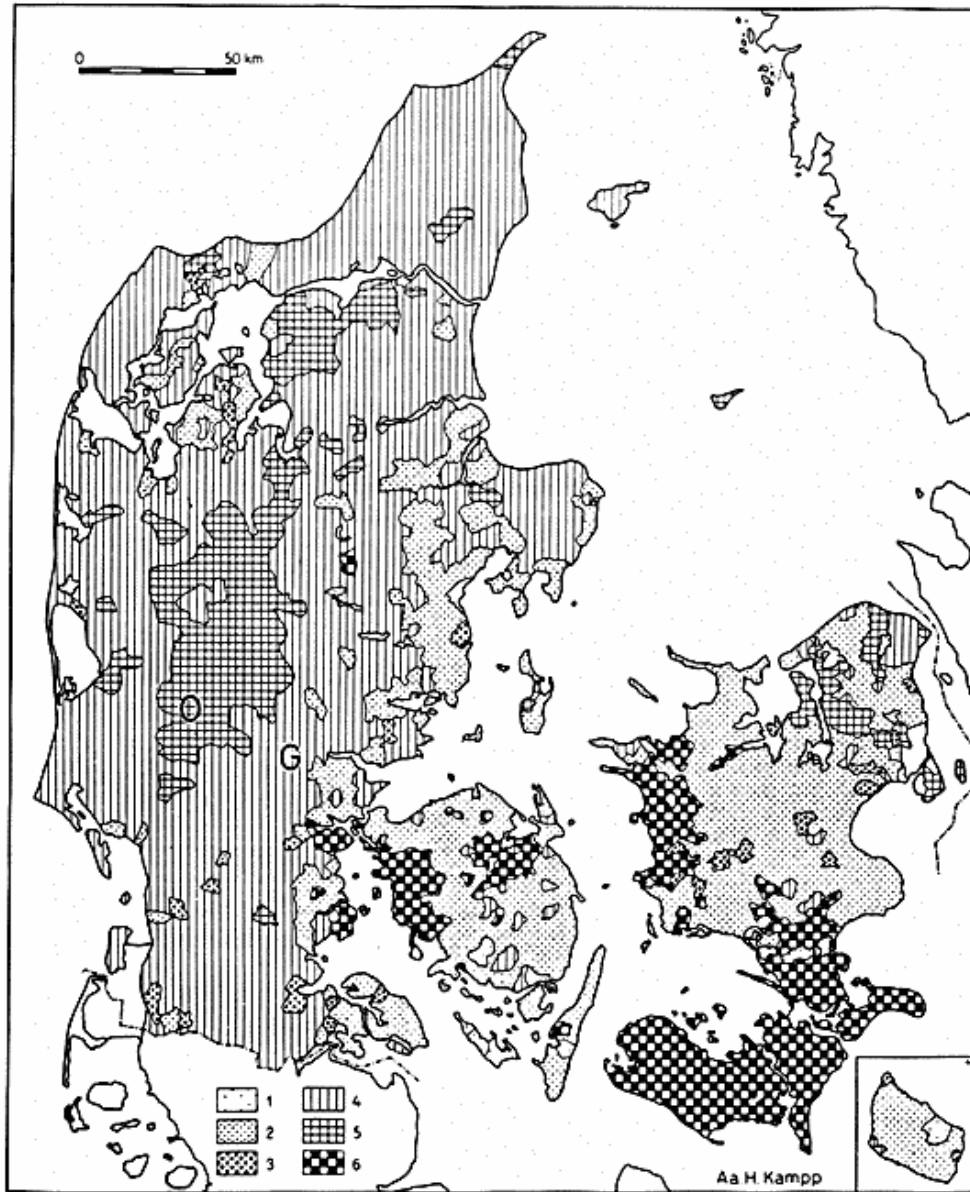


Fig. 5. The principal roots by area in 1951: 1. mangel; 2. fodder-sugar-beet; 3. sugar beet for fodder; 4. swedes; 5. potatoes, and 6. sugar beet for sugar production.

barley, the preference of oat is now limited to a smaller number of localities. Until 1938 oat was the predominant Danish cereal. Rye has ceased to be dominating in a number of North Jutland parishes, though it still dominates in dry, sandy soils.

The last figure represents the principal roots by area in 1951: 1. mangel; 2. fodder-sugar-beet; 3. sugar beet for fodder; 4. kohlrabi; 5. potatoes; 6. sugar beet for sugar production. Beet roots are

dominating almost everywhere in the isles (except North Sealand), in South East Jutland and, furthermore, in several Jutland parishes, particularly along the coast, especially along the shores of the western Limfjord. Factory sugar beet dominates the root crop in the parishes around the sugar factories; new factories have been established in this century. In the first part of the century mangel dominated the eastern part of Denmark; however, it has now been replaced by fodder-sugar-beet and sugar beet for fodder, which yields much more. It must be borne in mind that even beet for factory is mainly used for fodder: the whole top and about 80 per cent of the root, and it yields more than any other species of beet. Turnip, which at the beginning of this century dominated in a continued Mid-Jutland region, Vendsyssel, North-Djursland and Mid-Djursland, has been replaced especially by kohlrabi, which has now the preference in the principal part of Jutland; potatoes have also acquired an increased importance as root crop (though, botanically, it is not a root crop at all), not only around Copenhagen (for consumption), but also in the Jutland potato-region for fodder and factories for spirits and flour.

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