

# The effect of shelterbelts on climate and crops in danish agriculture

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Much of the Danish agricultural land, especially areas west of the glacial divide in Jutland, is composed of diluvial sands, moraine sands, and raised ocean floor, which have a comparatively poor ability to conserve water and are susceptible to wind erosion. (fig. 1).



Fig. 1 : PHYSICAL SOILS MAP.

Cultivation of the heath areas (originally about 700.000 hectares) has taken place during the past 100 years, in great part under the auspices of the Danish Heath Society. These areas are today relatively productive, and form a basis for a significant part of the Danish specialized livestock production. Cultivation has taken place concurrently with a large-scale establishment of numerous shelterbelts, which have given very meaningful protection against wind erosion, which, however, still creates a serious problem from time to time.

As an example it can be mentioned that in the year of 1969 an extensive sandstorm occurred, which led to considerable inconvenience and expenses for farmers in the affected areas. Expenses for removal of sanddrifts from municipal roads in south-west Jutland amounted to more than 1 million danish crowns. (OLESEN, 1969).

Since 1938 more than 50.000 kilometers of shelterbelts have been established. These are mainly single and double rowed hedges of white spruce (*Picea glauca*). However, a large part of these, and hedges established earlier, are now defective and, to some extent, ineffective.

Experience from agricultural areas exposed to strong winds has shown that planting of shelterbelts can prevent wind erosion and resulting difficulties in connection with re-sowing of spring crops, loss of fertilizer and valuable mould as well as formation of irritating and damaging sanddrifts effectively.

The reduced wind force in shelter mechanically

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counteracts damage to crops and individual plants caused by wind. Danish experiments (JENSEN, 1954), (OLESEN, 1974) have shown that, with a reasonable shelter density on sandy soils (the size of the sheltered area equal to the height of the hedge multiplied by 20 multiplied by the length of the hedge) an overall increased net production for ordinary agricultural crops normally averaging (after correction for the area occupied by hedges) 5 p.100 of crop value can be obtained.

The results of the Danish experiments are supported by (BATJER, NESS, LUCKEN, 1967) among others, German experiments and of Dutch research. (RHEE, 1959).

With a calculated normal height of 8-10 meters, attained after 6-10 years, the sheltered area will amount to 16 hectares per running kilometer shelterbelt. The annual value of the standard increase in yield will then amount to 2.865 danish crowns, or 180 danish crowns per hectare, plus increased cultivation certainty and

security against lasting land deterioration, the value of which it is impossible to calculate. Expenses (once and for all) for the establishment of 1 kilometer shelterbelt amount to 8.250 danish crowns or 515 danish crowns per hectare intensely sheltered cultivation area in 1976.

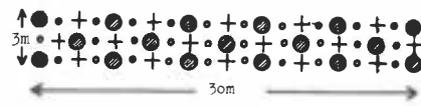
A large part of the existing spruce hedges are now attacked by root rot (*Fomes annosus*) dying, and very deteriorated.

The lapse of the existing hedges will in the meantime bring about a considerably increased risk of topsoil blowing, and a decline in cultivation conditions in general. It has been pointed out by Danish geographers (KUHLMANN, 1960) The Royal Veterinary and Agricultural College (ASLYNG, 1958), and the agricultural organizations, that an immediate and rational renewal of the shelterbelt system in Jutland must be considered necessary.

The actual and most urgent need for re-establishment of shelterbelts is estimated to comprise 15.000 running kilometers of triple-rowed shelterbelts. (fig.2).

COMPOSITION AND SPACING

Example of a design for a three row shelterbelt



- Permanent species
- + Fast growing species
- Undergrowth, shadetolerant species.



Lengthways cut of hedge.



- ◇ Fast growing species - to be removed later for instance : Alders, willows, poplars and others. The species are to be chosen according to local soils and exposure to wind.
- ◇ Permanent and high growing species for instance : Oaks, elms, maples and others. The species are to be chosen according to local soils and exposure to wind.
- ◇ Under-growth of bushes or bushy shadetolerant trees, for instance : Green alder, honey-suckle, lilac, rose, snowy mespilus and others. The species are to be chosen according to local soils and exposure to wind.

Fig. 2 : TECHNICAL DESCRIPTION OF THE PROJECTED SHELTERBELT-TYPE.

CONSTRUCTION OF THE SHELTERBELT. Principle for construction and composition of a three row shelterbelt with mixed stand of broadleaved trees.

In order to fulfill these requirements the Danish government has recently issued a law of economical support to the rise of shelter hedges. The European Agricultural Fund has also granted a support of 10.000.000 Danish crowns to a limited shelterbelt project.

The project is to, impede the occurrence of wind erosion to an appreciable and economically not damaging degree, in well-defined and more closely specified areas, under the above mentioned geographical and soil conditions.

An additional aim is to improve growth conditions for crops through the influence of the shelter thus provided on water balance and temperature conditions.

The shelterbelt system to be established is to be planned and coordinated so that fields of reasonable size are formed, and so that the best possible utilization of the landscape effect shown by dr. tech. Martin JENSEN can be achieved. (fig.3).

That is to say, the planting of shelterbelts is to be carried out systematically over large coherent areas so that the increased roughness of the landscape will give rise to an increasing equal shelter effect over the whole area or province. (JENSEN, 1964).

The project is, as well, to be organized in such a way that rational and modern working methods can be used in established and maintaining shelterbelts. Furthermore the shelterbelts to be established are to be planned

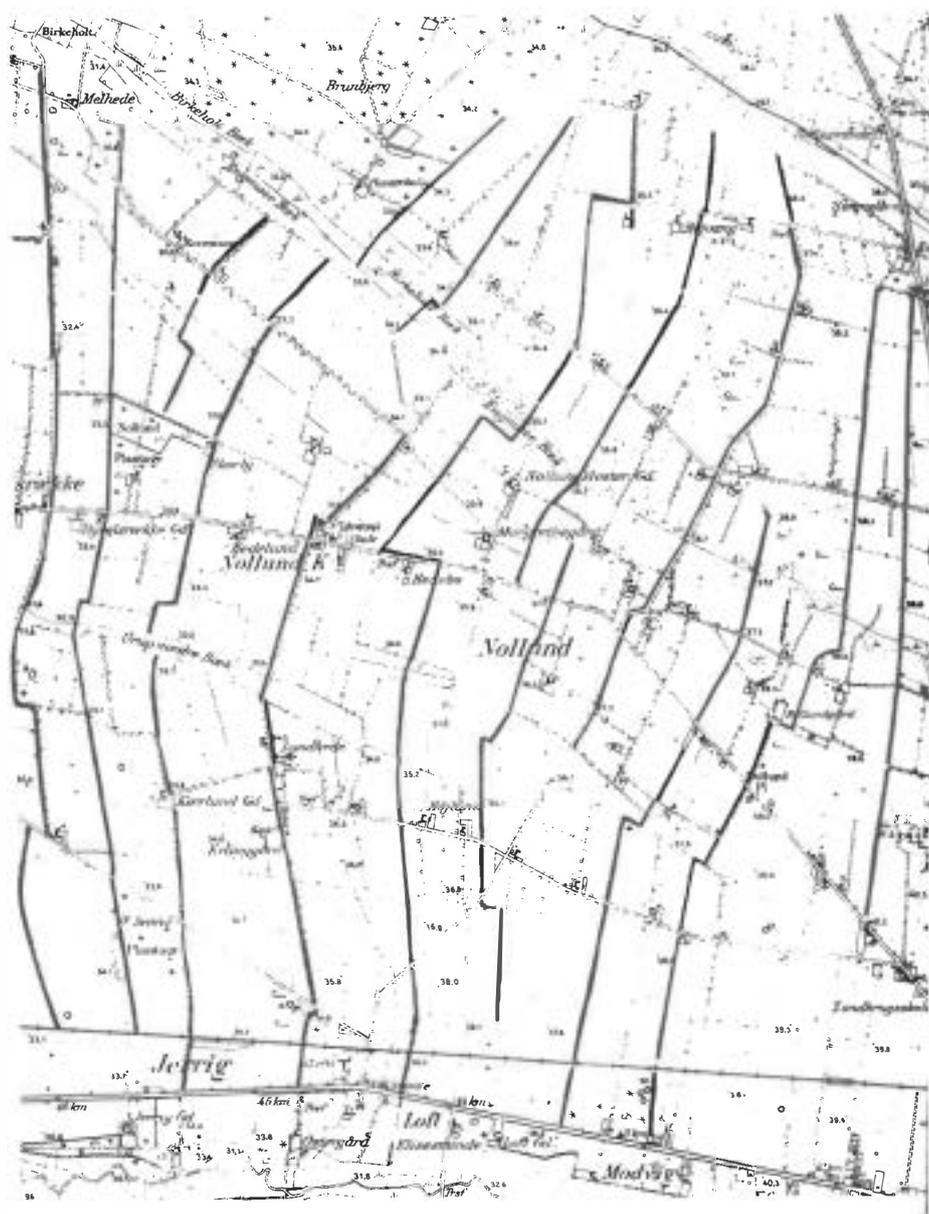


Fig. 3 : MAP SHOWING AN AREA OF GRINDSTED PARISH. With a suggested plan for a system of triple-rowed shelterbelts. Area covered by the plan :  $5\ 000 \times 5\ 000\ m^2 = 2\ 500$  hectares. Hedges drawn in : 40 kilometers, 5 meters wide. Area occupied by shelterbelts : 20 hectares = 0,8 p.100 of the total area.

so that they fulfil the requirements that can be imposed for lasting durability and effective shelter to the best possible degree.

It is hoped to establish triple rowed belts of deciduous trees, composed of several varieties of high, longlived, windtolerant trees and bushes at distances ranging from 250-400 meters, and preferably along

farm boundaries. (Tableau).

The organizational co-operation between the farmers involved will be accomplished by the forming of local planting-societies (Shelterbelt Guilds) covering areas with 50-100 landowners. These societies will participate in planning and are jointly liable for the landowners share in expenses.

### LIST OVER SPECIES OF TREES AND BUSHES UTILIZED IN THE HEDGES

#### PERMANENT TREES :

Pedunculate oak	( <i>Quercus robur</i> )
Sessile oak	( <i>Quercus petraeae</i> )
Sycamore	( <i>Acer pseudoplatanus</i> )
Norway maple	( <i>Acer platanoides</i> )
Wych elm	( <i>Ulmus glabra</i> )
Rowan	( <i>Sorbus aucuparia</i> )
Whitebeam	( <i>Sorbus latifolia</i> )
Birch	( <i>Betula pubescens</i> )
White spruce	( <i>Picea glauca</i> )
Sitka spruce	( <i>Picea sitchensis</i> )

#### FAST GROWING SPECIES (NURSE-TREES) :

Grey alder	( <i>Alnus incana</i> )
Black alder	( <i>Alnus glutinosa</i> )
Purple willow	( <i>Salix daphnoides</i> )
White willow	( <i>Salix alba</i> )
Balsam poplar	( <i>Populus trichocarpa</i> )

#### BUSHES FOR UNDERGROWTH :

Cherry rum	( <i>Prunus serotina</i> )
Green alder	( <i>Alnus viridis</i> )
Snowy mespilus	( <i>Amelanchier spicata</i> )
Lilac	( <i>Syringa vulgaris</i> )
Hawthorn	( <i>Crataegus monogyna</i> )
Honeysuckle	( <i>Lonicera Ledebourii</i> )
Alpine currant	( <i>Ribes alpinum</i> )
Grey willow	( <i>Salix cinerea</i> )
Crab	( <i>Malus Sargentii</i> )
Rose	( <i>Rosa rugosa</i> )

### RÉSUMÉ

Une grande partie du territoire agricole danois, en particulier les étendues situées à l'ouest du front glaciaire du Jutland, se compose de cailloutis fluvio-glaciaires qui possèdent une capacité assez faible de rétention en eau ; elle est exposée à l'érosion des vents (fig.1). La mise en culture de ces étendues s'est effectuée pendant les dernières 100 années, conjointement avec l'établissement à grande échelle de nombreuses

haies qui ont donné une protection importante contre l'érosion éolienne.

Les haies les plus anciennes, faites pour la plupart de sapins argentés, aujourd'hui amplement atteintes par le polypore (*Fomes annosus*), sont mourantes et fortement détériorées. De plus, quelques-unes de ces haies ont été plantées à une distance si courte qu'elles font,

dans une certaine mesure, obstacle à une amélioration de la culture du sol. Ces étendues sont cependant assez productives et portent une part considérable du cheptel danois.

La disparition des haies existantes entraînerait un risque accru d'érosion éolienne : l'exploitation deviendrait plus précaire et en général les conditions de cultures s'aggravaient. Le but des projets actuels de plantation de haies est donc de parer à l'érosion due aux vents ainsi que d'améliorer le climat de végétation : les effets d'abri obtenus agiraient sur la capacité de rétention en eau et le régime des températures. En plus de cela, il est supposé que les plantations auraient aussi pour objet de protéger le milieu et le paysage.

Les besoins actuels et les plus importants de rétablissement de haies-abri à trois rangs (fig. 2) sont estimés à 15 000 kilomètres. Pour satisfaire à cette nécessité, le gouvernement danois a récemment adopté une loi de soutien financier.

Les projets envisagent l'exécution coordonnée des plantations de feuillus et des dispositions telles qu'on obtienne des champs de grandeur raisonnable et un effet paysager aussi bon que possible. Les plantations de haies doivent être exécutées de façon systématique et rationnelle sur de grands territoires cohérents afin d'obtenir une augmentation de la rugosité du paysage et une augmentation correspondante de l'effet abri sur toute la région (fig.3).



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