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THE PREVENTION OF WIND EROSION IN AGRICULTURE

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The Problem

The wind erosion is a problem over more than 80 000 hectares in the Netherlands. The direct damages to the farmer are:

a. In reshaping a field that requires leveling or else cause in turn yield reduction and agrotechnical difficulties. As an extreme example 1 cm depth deviation of ground water table depth causes 1% reduction in yield in the flowerbulb area. This amounts to 500 Dfl. per hectare.

b. Covering up of seeds exposure of seeds or complete uprooting of seeds. The damage is by reduction in yield, replanting or just the loss of preparatory work. It is very often even for the cheapest field crops 200 Dfl. per hectare. The loss in potential income is much higher. 1500 Dfl. per hectare is probably one of the lowest values of a field. 10% of that as a damage is already 150 Dfl. (and this is a very small, hardly measurable damage)

c. After germination: covering of young plants, uprooting of young plants, sandblasting of young plants.
In areas prone to wind erosion this type occurs roughly once in three years (from talking to people) and then it is very bovious. The damage can be 30 - 100% (by people's impression). Thus even on the average a 10 - 30% damage annually amounts to not less than 150 Dfl. to 450 Dfl. per year on the cheapest crop. On more expensive crops it can run into numbers 10 - 50 times higher.

d. Older crops are damaged by sandblasting as long as the soil cover is not sufficient. It causes direct damage and possibly indirect, one, by infestation of deseases through injuries to the leaves (e.g. in potatoes).

We shall not enumerate other damages such as coverage of leaves by dust, loss of soil, contamination and transportation of deseases, inconveniences to people etc. It is very doubtful that farmers will be ready to pay for them.

Conclusions

a. The damage in wind erodible areas is on the average at least 150 Dfl. per hectare per year. A lot of damages very probably pass unobserved or unreported.

   In specific times and places the value of the damage is very much higher.

   1. In places: high value crops such as flowerbulb industry, (40 - 50 000 Dfl. per year crop value) about 10 000 hectares asparagus about 2 000 hectares, decorative plants horticulture and lastly the different vegetables.

   2. In times: We would get a much higher return to treatment for wind erosion if it could be applied only when and where the climatic conditions are ripe for damage and the crop is damageable.

Methods

In principle there are the following groups of methods

a. Changing the soil bulk properties by building up organic matter adding other soil materials etc.
   This approach may be payable sometimes. However there are

cheaper alternatives so that we are free not to consider it in details.

b. Wind Breakers

It is a must when the wind itself without sand can cause enough damage to justify it. It has many disadvantages in cultivation, utilization of land, local microclimatic effects initial cost and maintenance.

c. Maintaining continuous vegetative cover

d. Surface spray or spread

The maintenance of continuous surface cover is a good method if it is a natural part of the cropping system. If it has to draw on the same resources of land, sun, water, pesticids herbicids,factors and work without contributing to the direct vegetative production then they are doubtful. It may be found that they hinder the regular cropping system or that they fail to be successful within the season alotted to them.

The largest drawback of the vegetative cover that is not an organic part of the cropping system is that it requires a decision about the protection measures months before the protection is needed. Any system that can be decided upon only when weather conditions are predicted to be unfavourable is bound to have an economical advantage of 1 : 2 - 1 : 3 only on a time basis and some more on a place basis.

The cost of planting rye in September killing it by a herbicide in the spring is at least 250 Dfl. per hectare per year. This treatment has some drawbacks in the affection of soil temperature. It is not always successful(KNOTTNERUS).

Spraying and Spreading

In this group of methods a very large number of means and methods have been tried.

LEON LYLES ETAL (1974), ARMBRUST and DICKERSON (1971) LEON LYLES ETAL (1969). A special wind erosion conference was held by the

American Society of Agricultural Engineers at the University of Nebraska, Lincoln, June 27 - 30, 1976. Their estimate was that somewhere between 1 - 15 x 10^6 acres are damaged in the U.S.A. More than 6 x 10^6 were damaged in 1975-6. About 80% of the dry land cotton in the southern great plains has been replanted. A lot of work has been done on minimum tillage methods and the maintenance of vegetative cover. The idea is to reduce energy spenditure, contaminations by poisonous materials and other physical advantages to the ground. The above definition still holds that this method pays only if it is a part of the cropping system. Reduced amount of tillage may be a good idea if we are convinced that the crop does not need it. But then it will be done on that basis and not to prevent wind erosion. We should not forget that most vegetative residues have a very high economical value. In about 2500 references on wind erosion collected by FRY REAR and LYLES in the above conference many papers are about spreads and sprays. In the above papers by LYLES ETAL more than 30 different sprays are reported. Some were successful but none was found economical. In terms of 1977 prices the cheapest effective spray found by them was some 550 Dfl. per hectare. This treatment was hardly good for 6 weeks and had only a partial protective power. The one closest to it costs already twice the price.

Among the methods used in the Netherlands are:

Spray of liquid cow manure

Some 40 m^3/hectare in the flowerbulb area. It is good for gladiols. It is not good for gerimination of weaker plants (e.g. tulips). It can not be used when the plants are out. It is chemically not neutral and can affect the nutritional balance in an adverse way. Quality control, safeguarding a material etc. make it all a solution of a limited applicability. The price in June 1977 by a contractor was 875 Dfl. per hectare that makes it too expensive for most agricultural uses.

Compost

25 - 75 tons of city garbage compost (the low quantity is with fine grained compost) has been used successfully. The price of the material is at least 35 Dfl. per ton and it is mainly transportation. It is being used on roadsides by contractors that mix it in a hydroseeder with water, fertilizers and seeds. The contract price for a ready made grass is 5 000 Dfl. per hectare.

Straw or Reeds

The spread of straw is very expensive at the price of a few hundred Dfl. perton and several tons per hectare. The cover is not very good:

Several principles may be drawn for spreading and spraying materials.

a. It can be performed only when and where danger is expected by weatherforecast. Then the effective price will be reduced. Straw is very bulky and cannot be stored for a long period. Its application is not very fast and requires some special equipments. It cannot be worked out after germination. Manure and compost are also very bulky and require special equipment. Thus the spraying material should be of the smallest volume, storable for long periods, easily sprayed by standard or almost standard equipment. It should be possible to spray it when the plants are on the field.

b. The spraying material should be cheap.

c. The spraying materials should be without poisonous effects.

d. The spreading material should not carry deseases.

e. The farmer should be able to perform the treatment himself. The need for a contractor makes (a), above, impossible.

Furthermore the need for coordination always complicates things. The use of tools and labour on the farm most often does not involve any effective extra cost.

Some Notes About the Physics of Wind Erosion and Its Prevention

In sand areas most damage is caused by saltation movement (100 - 500 microns particls), KNOTTNERUS (1976). Saltation accounts for some 80% of the sand movement. Onset of erosion is affected strongly by the humidity of the air. At dry weather this happens around 30 - 33 kilometres per hour at 10 metres elevation wind speed (below 45% relative humidity). At high humidity the limiting velocity goes up to around 45 kilometres per hour (above 85% relative humidity).

The above velocities are predictable by several days weatherforecasting.

The saltation phenomenon is a chain reaction type process. Some very slight changes in soil properties (e.g. adsorbed moisture due to relative humidity in the air) that are hardly observable by some mechanical means are sufficient to reduce the efficiency of the chain reaction less than one.

The damage is not a yes-no preposition. It may be very useful to get an incomplete protection for a small fraction of the price.

Too many materials have been developed and tried on the basis of a "feel" or some simple mechanical measurements that had nothing to do with the mechanism of wind erosion and the eventual erosion.

KNOTTNERUS,(1976) summarizes his experience with a wind tunnel measurement

a. About 15 metres are necessary to obtain a assymptotic level of the saltation mechanism.

b. Sand grains larger than 500 microns and aggregates larger than 1 200 microns move away by rolling on the soil surface. Thus a large part of the damage mechanisms is eliminated by avoiding smaller grains.

c. The process of erosion stopes altogether at particles of 2.5 - 3 mm.

Any attempt to simply glue the soil particles to each other by a bulky material like asphalt or like many other emulsions is bound to fail because

a. It must use at least 250 - 300 litres per hectare (25 - 30 grams per squar metre). This has been found by experience and it amounts to some 25 - 30 microns average application thickness more or less like a minimum layer of paint on rough material.

b. The material has little or no regenerative power.

The material should be better water soluble which is then adsorbed on the soil. It should form as much as possible a sticky recoverable coating on the particles that will regenerate the protection and will tend to decay saltation of grains starting locally or imported from outside the treated plot.

The Soil Conditioner LIMA

It is a water soluble polielectrolite that fulfils most of the above mentioned properties.

1. Prevention of wind erosion in sand areas has been successful with application rates of 2 - 3 grams per m^2 or 20 - 30 kgs per hectare with water dilution of 0.2.- 1 mm depth over the field (2 - 10 m^3/hectare).
   About 5 grams per m^2 have been tried in peat areas.

2. Exposure of treated trays over 3 months did not reduce the effectiveness (without rain). Several irrigations over the sandy treated area left a marked effectiveness of the material.

3. Wind tunnel tests of an incomplete nature showed extremely high resistance as long as the surface formed crust was complete. Erosion strated always at a crack. In the peat experiment it gave 10 metre high wind resistance increase from some 45 to 60 - 100 kms/hr.

4. So far there has not been found any negative effects of the material on plants or animals at doses far larger than any to be used in practice.

5. There are no storage problems of long periods.

6. The material is insensitive to water quality.

7. It can be diluted from 30 - 40% solution to infinite dilution.

8. It helps germination and usually improves infiltration rates.

9. The application can be obtained by regular farm sprayers. It can best be applied by an irrigation system.
Special equipment for spraying liquid manure uses 14 m^3 tanks. It has been estimated that they need 2 hours work per hectare to make some 2.5 - 3 containers. One may consider a less efficient equipment (1/3 capacity) but it is necessary to spray only some 5 m^3/hectare (1/5 - 1/8) of the volume. In a working day one farmer can do easily 5 - 10 hectares.

Special equipment may be designed for the application.

The price of the material should not exceed around 10 Dfl. per kg. At the above rates of 30 - 50 kg/hectare this is 300 - 500 Dfl. per hectare. If applied every year. In all probability it should be possible

to substitute the presently used methods that cost nearly 4 - 5 times as much. It compares with the rye cover method with at least one advantage of applying only when and where necessary.

The real advantage will not be known unless experiments are made even in fields that do not seem to suffer much from erosion. KNOTTNERUS estimated the annual damage at 10×10^6 Dfl. per year. It is quite possible that it is much higher.

Action

Experiments are conducted by KNOTTNERUS using the Lima soil conditioner and field trials being prepared in Groningen and in the bulb growing area around Lisse.

These studies should be a part of a more general study of soil technology as the soil conditioner may solve also some germination problems, crust formation and reduced infiltration. Its application can be combined with the application of herbicides or through an irrigation sprinkler system (some 13% of agricultural soils in the Netherlands). Other methods of preventing wind erosion should also be considered as a part of a complete agrotechnique.

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