Windbreaks – a precondition for sustainable production of agricultural crops, soil protection and biodiversity conservation targets

Background

The species-rich, ecologically sensitive landscapes of East Georgia with their predominantly semi-arid climatic conditions are among the world`s most threatened areas by the effects of climate change. The pressure on natural habitats has drastically increased due to the energy crisis after the collapse of the Soviet Union in 1991. Nearly all windbreaks in Dedoplistskaro district – the pilot area of GIZ Project “Sustainable Management of Biodiversity, South Caucasus- were cut down by the population to meet their demand of firewood. More than 90 % of the former grid of about 1800 km of windbreaks is considered as not functional any more. The consequences are dramatic: wheat yield has been decreasing due to heavy winds in winter and causing erosion of the top soil. Expected changes in the regional climate will further exacerbate the situation.

Function of Windbreaks

Windbreaks consist of rows of trees and shrubs planted on agricultural land to protect crops and soil and to improve the micro climate for crops growing in their shelter. Windbreaks must be designed to perform their main function with optimum effectiveness. They are commonly planted around the edges of fields or farms. If designed properly, windbreaks around a farm house can reduce the cost of heating and cooling. They are also planted to help keep snow from drifting onto roadways and even yards. Other benefits include providing habitat for wildlife. Depending from the species planted the trees can be harvested to some extend for wooden products or berries and nuts could be harvested from fruit bearing species. Honey could also be an interesting side product of windbreaks according to the used species.

Design of Windbreaks

Windbreak structure – height, density, number of rows, species composition, length, orientation and continuity – determines the effectiveness of a windbreak.

Tree height is the most important factor determining the area protected by a windbreak. The wind speed reduction is measurable in two directions: at a distance of 2 to 5 times the height of the highest tree row before the wind reaches the windbreak barrier and up to 20 times the height behind the wind break (leeward side, the side away from the wind). For example in a 15 m high windbreak the wind speed reduction is measurable 30 m – 75 m before (on the windward side) and 300 m behind the windbreak (on the leeward side).

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Windbreak density is the ratio of the solid portion of the barrier to the total area of the barrier. Windbreaks consisting of deciduous species with 25-35% density have the most favourable effect. They prevent turbulences which occur directly behind very densely planted windbreaks and increase the length of the downwind protected area.

The number of rows, the distance between trees, and species composition are factors controlling windbreak density. Increasing the number of windbreak rows or decreasing the spacing of the trees increases density and provides a more solid barrier to the wind. In these cases, wind speed reductions are greater but the protected area is smaller.

Windbreaks are most effective when orientated at right angles to prevailing wind direction. In Shiraki Steppe wind blows from east to west so the main windbreaks are orientated from north to south at a distance of 300 m from each other. But as the wind does not blow exclusively from one direction there are also windbreaks oriented in an east to west direction at a distance of 1000 m between each other. The windbreak system thus forms a grid of closed rectangles.

The continuity of a windbreak also influences its efficiency. Gaps in a windbreak become funnels that increase the wind speed on the downwind side of the gap. So, gaps are very harmful to the fields behind the windbreak.

Microclimate modifications

The reduction in wind speed behind a windbreak leads to changes in the microclimate within the protected zone. As temperature and humidity usually increase there is at the same time a decrease of evaporation and plant water loss. Relative humidity is 2 to 4 % higher on the leeward side of a windbreak than in unprotected areas .The rate of plant water use is thus reduced and production is more efficient.

Most windbreak benefits come about indirectly because of changes in microclimate of the sheltered zone. A well designed windbreak can reduce soil erosion to near zero within the leeward side of 10 times the height of the tree row.

The “Dedoplistskaro Design”

Windbreaks in the Shiraki Steppe are planned and implemented according to the following rules:

The windbreaks have a width of 10 m on which three rows of trees and shrubs are planted in a mixture. The middle row consists of a tree species (ash, acacia, walnut) and the left and right row of small size tree species (like almond, celtis or wild pear) or shrubs (like soap tree, Russian olive). The mentioned species are used as they are drought hardy, winter hardy and pest resistant. The trees and shrubs are planted at a spacing of 2 m between each other and at 3 m between the rows.

The windbreaks have to be protected against fire from the fields (burning of harvest residues) with ditches dug all around. At the same time these ditches protect against intruding sheep into the plantations. Another option against fire is the ploughing of 3-4 m wide stripes between the windbreaks and the arable land before burning the harvest residues such like straw and others.

The design was practically tested in the fileds with planting of 38 km of windbreaks and can be replicated in the South-East part of the country by state, international and private stakeholders.

To ensure the sustainability of works to rehabilitate windbreaks, all activities have to be implemented in close cooperation with the owners of the adjacent fields, who take the tasks of the tending and protection of the windbreaks.

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