# Approach for “Rehabilitation of Windbreaks in East Georgia”

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## Situation Analysis

### Wind erosion in East Georgia

The soils in Shiraki Valley (Dedoplistskaro district) are rich and fertile with a deep humus layer. However, due to the lack of water – the annual precipitation is as low as 400 ml –, as well as high wind erosion, crop yields are far from being optimal. In winter, heavy storms hit the area blowing away seeds and topsoil. According to current climate-change scenarios, such extreme events are predicted to occur more frequently and more severely in future. If no wind protection is (re)established, Shiraki will most likely turn into a steppe over the next decades making field agriculture increasingly difficult.

### Windbreaks

Windbreaks are a wellknown measure against wind erosion. During the Soviet Union, more than 1800 kilometres of windbreaks were established in Shiraki Valley. They typically consist of rows of trees and bushes along the edges of agricultural fields to protect the topsoil from strong winds. Windbreaks reduce wind speed on their leeward side to a distance of up to ten times their height, and they improve the micro-climate for crops growing in their shelter by reducing moisture loss. In addition, windbreaks provide shelter and habitats for a wide range of plants, pollinating insects, wildlife and birds, including predators of agricultural pests.

### Threats

During the energy crisis following Georgia’s independence in the early 1990s, most of the old windbreaks were chopped down by local people and used as firewood. Today, fire and grazing – both by migrating sheep and by local (cattle) herds – are the biggest threats for windbreaks in Shiraki. Although soil analysis shows that burning is detrimental to soil fertility[1], many farmers still burn their fields between July and early September. Their intention is to bring back nutrients to the soil, to kill possible pests[2] and to remove biomass prior to ploughing (especially after fallow years). In 2015, more than forty of these fires went out of control, partially due to neglectance, partially because of strong winds. The fires jumped across protection stripes and ditches and destroyed more than 88% of the windbreaks restored during the GIZ project, as well as many old ones dating back to the Soviet Union.

A second source of fire are shepherds, both local ones (mainly cows), as well as migrating herdsmen (mainly sheep). Like in many other places worldwide, shepherds in Shiraki burn dry grass to facilitate the growth of fresh, green grass after the next rain. Some of these fires are deliberately set inside the windbreak areas, some are set outside but run into the windbreaks.

### Weak institutions

The institutional and legal frame for restoring, maintaining, protecting and managing windbreaks is still weak. As of March 2018, neither municipalities nor line ministeries have clear obligations and mandates to govern windbreaks. This institutional ambiguity also contributed to the severe losses of windbreaks

[1] Soil analysis was done during the economic analysis of the costs of agricultural burnings (see Westerberg et al. 2016).

[2] Although there is no scientific evidence that post-harvest fires can help to control pest, farmers tend to believe in this approach.

during the fires of 2015. Fire prevention was not suficient[3], and fire response was further aggrevated by the (re)centralised responsibilities regarding wild fires.[4]

## Vision and objectives

The vision is to sustainably rehabilitate Georgia's windbreaks in order to protect arable fields from wind erosion and to provide firewood and by-products to the local population.

## Approach

The approach described here was originally developed during a BMU-funded project on the climate-tolerant rehabilitation of degraded landscapes (2008-11). It was developed further under GIZ-SMBP (2011-2015). After the fires 2015, the large-scale rehabilitation of windbreaks was put on hold. Instead, the technical approach was further optimized between 2016 and 2018 on 5 ha of additional test windbreaks, in close cooperation with the State Research Center for Agriculture (under MoA) and the NGO Friends Association of Vashlovani Protected Areas.[5]

### Selection of drought-resistant bush and tree species

A broad range of tree and bush species were tested in Shiraki over almost ten years. While many species survive during humid years, extremely dry and hot years (e.g. 2014, 215, 2017) were used as stress tests to select the more robust trees and bushes. Based on the field tests, the following species are recommended for Shiraki Valley (survival rates listed are derived from several different tests). Alien species (possibly invasive) are marked with an asterix *****:

Bushes for outer rows:

Almond (*Amygdalus communis*), survival rate: 40-80%

Grows up to 3-10 m; fruit bearing; good regeneration after drought (2014/2015: increase of survival rate from 24%-76%). The local provenience, *Amygdalus georgica* Desf. (3-5 m), which is common in the area surrounding Shiraki may be used, although it grows less high than *A. communis* (5-10 m).

China Tree (*Koelreuteria paniculata*), survival rate: 50-90% *

Grows up to 3-5 m; firewood; native to eastern Asia; considered as invasive in USA.

Russian Olive (*Elaeagnus angustifolia*), survival rate: 35-70%

Grows up to 3-7 m; nitrogen fixing; flowers attract bees (honey); edible fruit, firewood; very drought resistant. Resistant against animal browsing.

Pistachio (*Pistacia mutica*), survival rate: 70-90%

Grows up to 7 m; fruit bearing; drought-tolerant and often planted to combat soil erosion in arid regions. Pistachio is growing frequently in the neighbouring Vashlovani Protected Area.

[3] Despite warnings by farmers and GIZ to Dedoplistskaro municipality and the Ministry of Environment and Natural Resource Protection in early June 2015.

[4] In 2015, municipalities were not in charge of firefighting anymore after the mandates had been re-centralised under the Ministry of Interior (see Goldammer 2014).

[5] Between 2011 and 2016, the rehabilitation of windbreaks, including the further development of the rehabilitation approach, was funded Austrian Development Cooperation. The original goal of 100 km of rehabilitated windbreaks had to be given up after the fires of 2015.

Wild Pear (*Pyrus caucasica*), survival rate: up to 80% (only tested in one year)

Grows up to 7-9 m; drought-resistent; fruits are eaten by animals. The species is widely distributed in the Vashlovani Protected Area.

Trees for central row:

Black Locust (*Robinia pseudoacacia*), survival rate: ca. 50-75% *

Grows up to 25 m, firewood, good for fence/vineyard posts, flowers attract bees (acacia honey), nitrogen fixing, main species in old Soviet windbreaks; popular breeding tree for many bird species; native to north-America but widespread over Europe and temperate regions of Asia. It regenerates to some extend after fires through underground shoots.[6]

Common Ash (*Fraxinus excelsior*), survival rate: 40-55%

Grows up to 25 m; firewood, timber, handles; Georgia lies in the natural range of this species. The Ash trees, planted during the early project implementation phase, proved to have good survival rate and good mean annual increment if not browsed.

Caucasian Hackberry (*Celtis australis* subsp. *caucasica*), survival rate: 50-80%

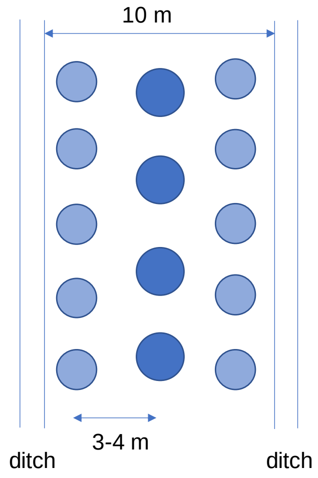
Grows up to 15-20 m; very hard wood, good for firewood, valued for drought tolerance and beneficial for different insects, such as butterflies; seeds and fruits are eaten by wild animals and birds.

Field Elm (*Ulmus minor*), survival rate: 50-80%

Grows up to 30 m. Elm trees may be affected by a widespread fungus ("Dutch elm disease); possibly resistant.

[6] Although, autochthonous species should be preferred in order to avoid the invasion of alien plant species in nearby protected areas, *Robinia* may be treated as an exception (due to its robust properties) as the windbreaks are confined to large agricultural areas in quite some distance from the riparian and floodplain forests where the species constitutes a threat to native trees.

## Design of a windbreak




In a windbreak three rows of different tree and shrub species are planted with a width of 10 m and a distance of 400-500 m between them. While the middle row consists of large trees, the outer rows include small trees or shrubs (for species, see above). Spacing between trees and shrubs is 2-3 m between each other, and 3 m between the rows in chess order.

## Preparation of seedlings

Seeds are collected from the wider rehabilitation areas in order to ensure the appropriate provenance (ideally after a drought to ensure that some drought-resistance may exist), and their adaptation to the specific ecological conditions of the site. The seeds are then prepared professionally for planting in a nursery (such as the state nursery in Sartichala). Seedlings to be transported over a larger distance (as from Sartichala) need to be grown in special containers to ensure that the root system develops well, and to minimize damages during transportation. If grown near the planting site seedlings may also be bare-rooted, if the transportation time is short. In any case, the roots need to be kept humid, and the seedlings have to be protected from direct sun (e.g. not to be transported on an open pick-up car). It is further important that the seedlings are sufficiently big to survive.[7]

## Soil preparation and substrate

Experiments showed that while deep ploughing removes competing plants from the plot, the water retention of the soil gets substantially decreased. Hence, only planting holes should be dug, digging of planting ditches (after ploughing) is not advised for semi-arid areas, such as in Shiraki.

In the trials of 2016-18, six different regimes of substrate were tested, including various combinations of Teravit, Perlite and peat (combined), straw and manure (combined), and wool pellets. The most promising combination measured by survival rate are:

Teravit (15 g per seedling) + straw/manure (3 kg of burnt manure per seedling) – average survival rate (across all species): 55%

Straw/manure (3 kg of burnt manure per seedling) + wool pellets (150 g per seedling mixed with soil) – average survival rate (across all species): 59%

All other combinations resulted in a survival rate less than 41%. The combination of Teravit + straw/manure + wool pellets was not tested but may be the most promising one.

## Planting and protection of seedlings

The seedlings are planted according to a well-designed plan (see graphic above) in autumn. This allows the root to rest for a while, and it enhances the chance for sufficient precipitation (rain and snow). The planting sites are prepared to ensure water flow. Experiments have shown that planting the seedlings into holes is far better than planting them into ploughed ditches, as too much soil moisture is lost in the latter case, and more watering is needed. Protective tubes are advisable during winter. They provide good protection against wind and animals with an increase of the survival rate by more than 70%. The tubes must have ventilation holes, and they should be 120 cm high. They will fall apart after 4-5 years when the plants are high enough to withstand grazing.[8] In very hot summers the tubes may become

[7] In 2013/14 *Robinia* seedlings were only nine months old when planted – most of the seedlings did not survive the first winter.

[8] The remaining plastic needs to be removed from the landscape as it is not bio-degradable.

harmful due to very high temperatures inside. In such a case, they should be removed. Protection against animals can be ensured by surrounding the seedlings with three sticks wrapped around by thorny branches (e.g. *Gleditsia* or *Robinia*).

In order to reduce competition for water and nutrients, mechanic weeding needs to be conducted (at least in the first year) in late spring and/or early summer within a radius of 60 cm around the seedlings.

Special plastic sheets may help to prevent the growth of competing weeds and support the collection of water.[9]

In some years, large populations of rodents (mice, voles) damage the roots of seedlings. It is advisable to erect wooden poles with horizontal T-shape endings as sitting opportunities for resident and migratory birds-of-prey (kestrels, buzzards, harriers etc.) and shrikes (*Lanius* sp.) as natural predators. In addition, the roots can be protected by surrounding them (also in the soil during planting) with field stones (in the shape of a hemisphere).[10]

## Watering of seedlings

While the original rehabilitation concept did not foresee any additional watering (after a first watering immediately after planting) to be cost-efficient, the stress years of 2014, 2015 and 2017 clearly showed that at least emergency watering (minimum 10 l per seedling) is needed. The tests in 2015-17 revealed that up to three additional times of watering (i.e. in total four times per year!) may be needed in the second year (and possibly even in the third year). As the experience with earlier plantings from 2009 showed, most plants are safe and fully self-sufficient after four years.

## Protection of windbreaks

In earlier years, the project had employed a two-person patrol to protect the windbreaks (mainly from fire and browsing). However, such project-funded arrangements are not sustainable, and more durable (and fundable) solutions are needed. As an immediate response to the devastating fires of 2015, the head of Dedoplistskaro municipality established a working group. The working group developed a fire prevention and fire-fighting plan[11] and successfully protected the (remaining) windbreaks in 2016 and 2017. It is envisaged that the new policy for windbreaks will lay out the principal arrangements for the future protection and maintenance of windbreaks.

## Other incentives

One shortcoming of windbreak rehabilitation is the great time difference between rehabilitation and full functioning of the windbreaks. The farmers who rehabilitate or plant new windbreaks might not be the same farmers who are going to benefit from them some 20-40 years later. Hence, current farmers often are not very interested in investing time, land and resources into windbreaks. This shortcoming may either call for state intervention to secure soil fertility as a national priority (e.g. as a state programme under the framework of the agricultural strategy or land degradation neutrality), or it may be addressed through other incentives, such as the parallel utilization of windbreak trees (e.g. wild fruits, firewood through some tending activities) or the shade provided by windbreaks. During the windbreak tests of 2016-18, intercropping of potatoes and onions into windbreaks was successfully tested by the NGO Friends Association of Vashlovani Protected Areas with a harvest of some 700-800 kg of potatoes and some 700 kg of onions per kilometre of windbreaks (on a narrow stripe 50 cm wide).

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[9] In the case of pines (*Pinus eldarica/brutia*), the needle length was significantly longer when such plates were applied.

[10] This technique has been invented by a German fruit tree farmer. According to his experience it takes less than half a minute per tree to protect the roots (if stones are available).

[11] Built on the Integrated Fire Management Plan developed by GIZ-IBiS, see Goldammer 2014).

## Shortcomings

Although the first results of the BMU project were quite promising with survival rates of more than 70% (April 2014), subsequent dry and hot years (2014, 2015, 2017), as well as the additional field tests in 2015-17 showed that rehabilitation without additional watering in subsequent years (minimum in Year 2) is not possible. In addition, the risks from agricultural burnings and browsing animals remain high.

### Frequent fire damage

A declining trend of fire incidents was observed from 2007 until 2014 (see Table 1), induced by the introduction of disc-cultivation by GIZ. Through disc-cultivation plant residues are mechanically incorporated into the soil without losing soil moisture, which makes (at least in relatively humid years) burning obsolete.[12] However, in 2015 devastating fires occurred when 80% of Shiraki's fields were burnt and the fires spread (due to strong wind) across the protection ditches into the windbreaks destroying almost 90% of them. The main underlying cause of the burning practice was the high amount of biomass on fields due to a very humid spring and a high proportion of fields that were left fallow for the year before (because of a severe drought in 2014).

| Annually burned area in hectare and percent from 2007 until 2016 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| in ha | 6,744 | 12,004 | 263 | 8,886 | 879 | 3,854 | 1,512 | 5,218 | 33,767 | 29,245 |
| in % | 16% | 28% | 0.6% | 22% | 2% | 9% | 3% | 12% | 79% | 66% |

Table 1: Annually burned area in hectare and percent (of Shiraki) from 2007-2016

Besides destroying valuable habitats, the economic losses caused by the agricultural burning practices are high. In case the fires were prevented and the residues (straw) was either incorporated into the soil (through disc-cultivation) or sold for briquetting or pellets, farmers in Dedoplistskaro would enjoy the net present value (NPV) of approximately GEL 16.9 million over ten years. Besides, the Georgian society would enjoy benefits in the order of GEL 16.8 million (mainly through avoided emissions), and the global society would benefit in the order of some GEL 21.2 million (including the value of sequestered carbon).[13]

### Continued browsing of livestock

Especially during periods of drought and lack of available livestock fodder, herders tend to lead their animals into the windbreaks for grazing, despite of a local regulation[14] that forbids such practice. This holds for both, local herdsmen (mainly cows) and transhumant shepherds (sheep). While the use of plant protectors has increased the survival rate of seedlings by 72% and may be sufficient to ensure protection against browsing, the use of fire, associated to grazing (for supporting the growth of fresh grass) calls for a new approach. Additional ideas include the integrated fire management approach mentioned above, as well as considerations regarding migration routes (for sheep) and alternative fodder (for cattle), possibly linked to crop rotation on arable fields (e.g. by planting alfalfa as livestock

[12] In dry years, the decomposition of organic matter is slower and the soil tends to become too compacted by disc cultivation. Hence, occasional ploughing might still be needed if burning shall be avoided.

[13] For calculations see Westerberg et al. 2016. The figures represent net present values over 10 years with an annual discount rate of 4%. The calculation represents the possible gains by imposing a ban on agricultural burning and, in parallel, utilizing agricultural residues for straw pellets.

[14] Decree of district council (*sakrebulo*) of Dedoplistskaro municipality N29 from 15 June, 2009.

fodder). In addition, more consequent legal prosecution – preferably of the livestock owners, not the (often poor) shepherds – is needed to change this detrimental practice.

### Occasional wood cutting (for firewood)

Although today the pressure on wood resources is less compared to the energy crisis of the early 1990s, some trees and bushes are still cut every year to fulfil the firewood demand of individual people. Once the windbreaks have reached a certain age, tending measures will provide wood residues that could be pressed into briquettes as firewood. In the meantime, alternative fuel may be provided in the form of briquettes from tending cuttings in nearby forests (planned) or of agricultural residues, combined with energy efficiency measures.[15]

### Unclear ownership and institutional responsibilities

Unclear ownership and institutional responsibilities are possibly the most relevant constraint regarding the sustainability of the approach. In the past, (some windbreaks (25-30 and 45-65 m) were supposed to be managed by the National Forestry Agency (NFA), while others were on the balance of the Ministry of Economic Development.[16] Nowadays, not even those farmers who were involved in the restoration project, and who owned fields adjacent to the windbreaks considered them as their own. This lack of ownership also became apparent in the farmers' attitude during replanting activities. The farmers (or their employees) were paid for all planting and tending activities without any own contribution (neither cash nor in kind).

The issue was noted at political level and three important steps were taken. (1) A working group under the National Forest Programme (NFP) of Georgia selected the restoration and protection of windbreaks as their key topic; (2) the former Ministry of Environment and Natural Resource Protection (MoENRP) and the former Ministry of Agriculture (now merged into the Ministry of Environmental Protection and Agriculture), with support of GIZ and REC Caucasus, developed a policy for the rehabilitation and protection of windbreaks; and (3) the preparation of a new law on windbreaks was initiated (to be based on the policy). The forthcoming law on windbreaks will clarify the situation and ascribe clear responsibilities regarding maintenance and management of windbreaks. However, it is still unclear to what extend the new law will also address the allocation of resources needed to manage windbreaks sustainably.

## Next steps for further adaptation

In order to address the unsolved issues adequately, a more systemic approach is currently being developed, including the following additional elements:

- Preparation of the new Law on Windbreaks (with links to Law on Local Self-governance)
- Continuation of the local working group on windbreaks (involving all relevant stakeholders)
- Provision of training and limited equipment for institutions newly responsible for windbreaks
- Revision of the integrated fire management plan (following up on the 2015 fires)

[15] The forest-energy link will be the main focus of GIZ's new project in Georgia (starting in early 2019).

[16] During the Soviet Union, windbreaks were divided according to their protective functions: narrow windbreaks (10 m) to protect arable fields, and wider ones (25-30 m and 45-65 m) to function as protective forest (against strong winds). Windbreaks next to arable fields belonged to the so-called "Kolkhozes"', while the wider windbreaks were on the balance of the State Forest Fund. In most cases, the State Forest Agency that managed the wider windbreaks was asked by Kolkhozes to also manage their windbreaks. In addition, windbreaks were planted along the roads. The management was also often delegated to the State Forest Agency.

- Linking need for livestock fodder to crop rotation on arable fields (legumes, see Approach for Climate-adapted Wheat Cultivation); alternative pastures
- Promotion of alternative fuel / energy efficiency in Dedoplistskaro district
- Continued monitoring of survival rates and fire incidents
- Further development of intercropping with useful plants (see tests with potatoes and onions)