THE ECONOMICS OF LAND DEGRADATION

Policy Brief

Reducing wildfires in Georgia

Assessing the case for implementing and enforcing a law to ban crop residue burning in Dedoplistskaro district

- A combination of anthropogenic and climatic factors, particularly traditional burning of crop residues, are reducing agricultural yields in an important food producing region of Georgia.
- There are a number of private and public costs and benefits associated with two scenario reducing the indendence of burning in the agricultural sector. For both scenarios there is a net private and public benefit.
- Reducing burning will also have a positive impact on a number of environmental metrics and support achievement of the United Nations Sustainable Development Goals.

Background

Fire is used extensively in agricultural practices around the world, contributing to an estimated 8–11% of global fires. The Russian Federation, for example, is the largest contributor to agricultural burning globally producing 31–36 % of all agricultural fires (Korontzi et al. 2006). Georgian farm systems are no exception – fire is used extensively after the harvesting period.

In the summer of 2015 large wildfires ravaged the Shiraki valley (43,000 ha) within the Dedoplistskaro district in Georgia (Figure 1). The valley is known as the breadbasket of Georgia, having provided the country with the lion's share of its wheat for centuries. With its deep soils with high humus content, the valley offers significant potential for high agricultural yields. However, a combination of warmer climates, more frequent droughts, strong winds, the degradation of windbreaks and non-sustainable agricultural practices has led to reduced agricultural yields.

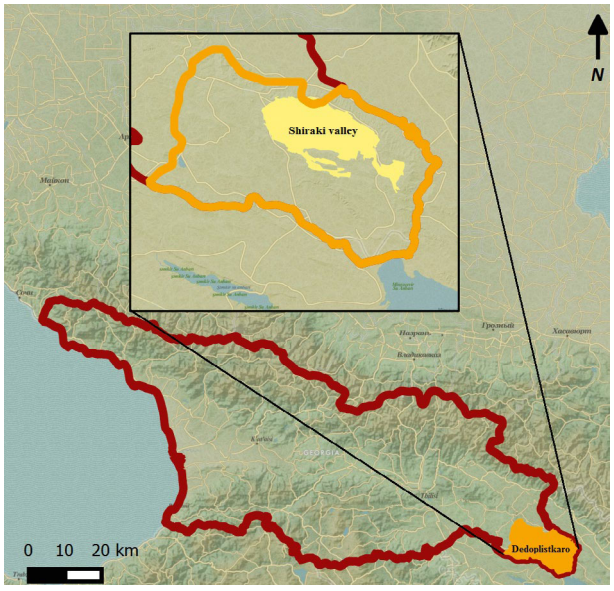
The degradation of windbreaks started after the fall of the Soviet Union, when the population of Dedoplistskaro began to cut trees to meet the demand for fuel.

In a project implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), from 2008 onwards, around 70 km of windbreaks have been rehabilitated. However, the wild fires of 2015 severely damaged all remaining windbreaks and restoration efforts by GIZ.

In the context of increasing occurrence of dry spells and heat waves favoring the recurrence of more frequent and larger fires, it is imminent that the main driver of fire – namely, human ignition of crop residues – is put under scrutiny.

FIGURE 1

Location of the Dedoplistkaro district of Georgia.



The Georgian Ministry of Environment has therefore initiated legal changes to ban crop residue burning. Enforcing such a policy, however, needs to be justified on economic and ecological grounds. For this purpose, an ecosystem service valuation study has been undertaken, analysing the economic benefits and costs of implementing such a policy. The preliminary results hereof are presented below. The time frame for the analysis is 10 years (2017–2026), assuming the policy could be enacted in 2017. Future cost and benefit are discounted into present value terms using the Georgian real interest rate of 4 %.

Scenarios

This policy brief compares two scenarios (Figure 2):

1. **No change** – a simple continuation of the 'business as usual'.

2. **Ban on burning scenario –** A legal action to prohibit crop residue burning. Small and large farmers stop burning and decide to integrate residues in the soil, and/or collect, compress and sell straw bales depending on net-benefits of each activity to each of the farmer segments.

The latter scenario is valued relative to the former, business as usual.

Benefits and Costs

Modeling results linking likely future fire hazards and windbreak destruction rates[1] suggest the remaining 50 km of windbreaks could be lost within 10 years if there is no policy change.

The biophysical and social impacts of terminating crop residue burning are calculated for two categories of farmers: large farmers (with 5 ha or more) and small farmers (less than 5 ha of land). This is done because small and large farmers face distinctly different costs, yield and price structures.

To estimate the value of protecting the remaining windbreaks and the welfare economic impacts of banning crop residue burning, a hypothetical market was created using a choice experiment valuation survey (example of choice set Figure 3) using increases or decreases in the yearly land registration fee as the payment vehicle.

1 *To project the possible incidence of fire hazards from 2017 to 2026 under no policy change, random numbers were drawn from a normal distribution characterised by the same mean and standard deviation of the fire events in Dedoplistskaro from 2000 to 2015 (collected using MODIS data). Windbreak monitoring data from GIZ was used to establish a correlation between wildfire severity and windbreak mortality.*

FIGURE 2

Outcomes for scenarios 1 and 2.

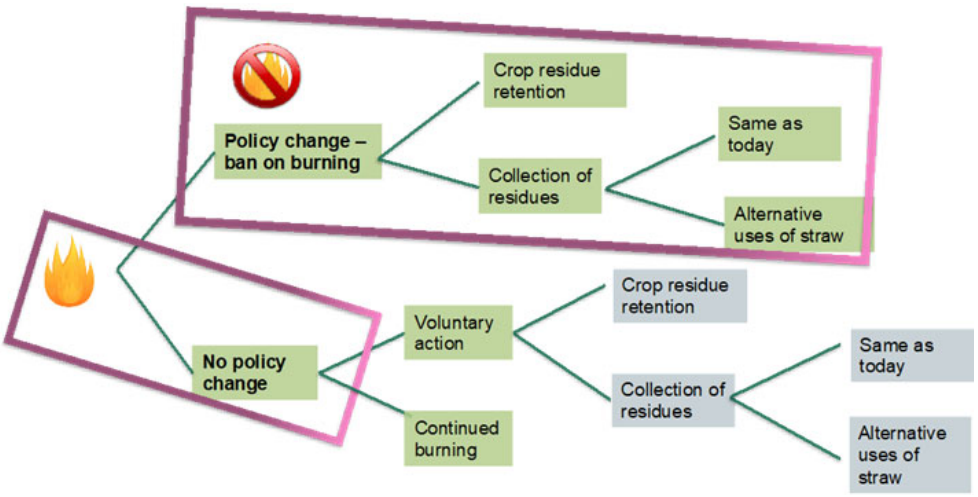


FIGURE 3

Example choice experiment survey questionnaire

Choice set 13	STATUS QUO	Future Alternative 1	Future Alternative 2
Windbreaks	20% windbreaks 	No windbreaks left	20% windbreaks 
Crop residue management	Fire allowed 	Fire allowed 	Fire banned 
Land registration fee Relative to what you pay today	87 Lari/ha 0 Lari/ha	80 Lari/ha -7 Lari/ha	110 Lari/ha +22 Lari/ha
Your choice			

The survey was undertaken with 300 farmers in Dedoplistskaro and was also used to form all valuation questions below.

Value of protecting remaining windbreaks and banning crop residue burning

The choice experiment results based on 300 randomly selected interviewees reveal that the average farmer, whether small or large, would experience an annual present value welfare loss of GEL 6.4 per year over the 10-year time horizon, if remaining windbreaks were to be lost.

Furthermore, 70% of farmers would prefer a legally enforced ban of crop residue burning and that the ban would deliver an Expected Annual Net Benefit (EANB) of GEL 36 to 38 per hectare land cultivated, with small farmers enjoying the slightly larger EANB. This implies that individually farmers have a preference for using collective action through enforcement rather than voluntary action to better protect them and Shiraki valley landscapes against damages from fires originating on other farms.

While the individual farmer can decide not to burn, fires typically spread across fields and only a comprehensive ban would prevent this happening. The present value benefits of enforcing such a policy amounts to 16.9 million GEL (Figure 4), while the present value benefit of protecting remaining windbreaks is in the order of 1.1 million GEL.

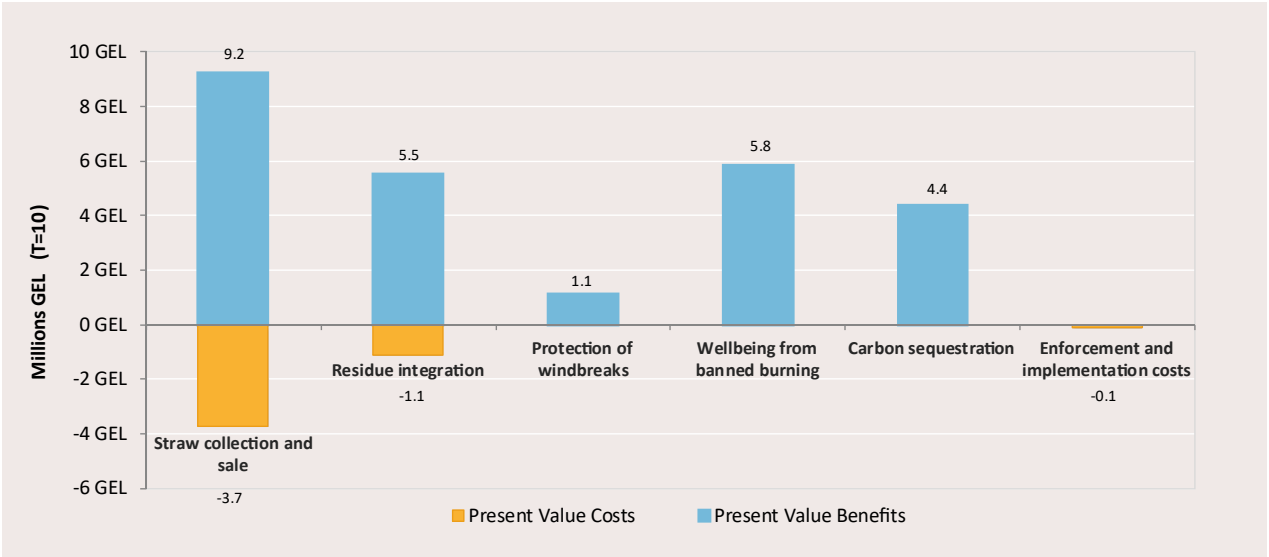
Value of straw as fertilizer

Removing or burning straw exports nutrients and soil organic matter out of the field and leaves the soil susceptible to erosion.

Shredding of straw during harvest and subsequent integration of straw into the soil builds up soil organic matter and helps retain moisture in the ground.

FIGURE 4

Aggregate PV benefit and PV costs in million GEL from a legally enforced ban of crop residue burning (r=4%)



* *Error bars illustrate the 95% confidence interval for these values.*

** *Assuming here that half of all straw is collected and sold, and the other half is integrated in the soil*

By using an integrated water balance crop model known as AquaCrop, calibrated with data from soil samples taken in Dedoplistskaro, it was found that agricultural yields would increase by between 11% and 23% within three years if farmers integrate straw into the soil instead of burning it. Farmers who burn every year have the most to gain (23%) from terminating burning.

Small and large farmers face different rental costs of machinery used for integrating straw into the soil. Accounting for these differences, whilst using 2015 farmgate market prices for cereals, it was found that small farmers who stop burning can expect GEL 78 per hectare in additional annual net benefits if they end burning, whilst large farmers can expect GEL 105 per ha in annual net benefits.

Straw for sale

The burning of residues represents a lost economic opportunity in the sense that residues can no longer be used for fodder, fuel or animal bedding.

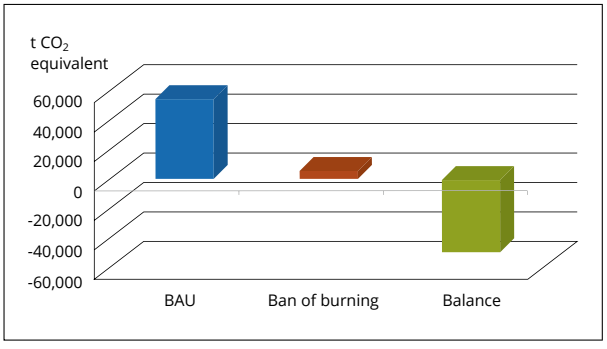
The expected net annual benefit of collecting and selling straw for the large farmer is in the order of GEL 147 per ha per year. Small farmers, however, face higher straw collection prices and lower yields relative to large farmers, which makes it uneconomical for them to collect and sell straw bales.

Value of avoided carbon emissions

The Agriculture, Forestry and Other Land Use sector is responsible for more than one-third of total greenhouse gas (GHG) emissions. At the same time, the farming sector offers considerable mitigation potential from soil carbon sequestration and the avoidance of new emissions sources from fires. GHG emissions from the burning of crop residues consist essentially of methane and nitrous oxide gases, while the destruction of windbreaks leads to below and above ground carbon emissions.

FIGURE 5

tCO_2 equivalent emissions with and without a ban on burning and total carbon balance (2017–2026)



Implementing and enforcing a ban on burning results in approximately 50,000 tonnes CO2 equivalent tons of avoided carbon emissions over 10 years (Figure 5), calculated using Tier 1 of IPCC 2006 in the FAO X-ANTE tool. Using a conservative estimate of the social cost of carbon of 94 GEL/ton CO2eq (from EPA 2015) and a real discount rate for Georgia of 4%, the value of the avoided global damages amounts to 4.4 million GEL (Figure 4).

Cost of implementing a policy

Implementing and enforcing a ban on crop residue burning involve costs associated with raising awareness, organising meetings and workshops with farmers, running information campaigns in newsletters and patrolling during the fire seasons.

Based on estimates from the Georgian Ministry of Environment and GIZ, information and enforcement costs sum up to approximately 122,000 GEL in present value terms over the 10-year accounting period for the Dedoplistskaro district (Figure 4).

Results

When accounting for the contribution of straw to soil nutrients and the market value of straw bales, it is worthwhile for farmers to forgo burning, resulting in a NPV benefit to small farmers of GEL 0.8 million and between GEL 16 and GEL 17.5 million for large farmers.

In other words, small farmers can expect GEL 5 of benefits for every GEL 1 they spend, while large farmers can expect between GEL 3 and GEL 7 of benefits for every GEL 1 they spend.

- If residue burning is prohibited by law across the district, windbreaks will be better protected and the risks of large scale catastrophic fires minimized. NPV welfare benefit of protecting remaining windbreaks over the 10-year period is GEL 56 per hectare for both large and small farmers. Over a 10-year period, the ban on burning scenario result in an aggregate NPV benefit of 16.8 million GEL for the whole of the valley.

- Accounting for carbon sequestration, which is a global public good, the global net-benefit associated with banning crop residue burning in the Dedoplistskaro district amounts to 21 million GEL.

TABLE 1

Table 1: Benefits, Costs, Expected Annual Net Benefit (EANB), Net Present Value and Benefit Cost Ratio from ban on burning in Georgian Lari (GEL)

Benefits and costs	EANB/ha	NPV/ha	NPV district wide	BCR
Residue retention and soil integration				
Small farmers	78	632	0.8 million	3.7
Large farmers	105	855	7.8 million	5.2
Collection and sale of straw residues				
Small farmers	- 5	-40	- 32'000	0.9
Large farmers	147	1196	11.0 million	2.4
Welfare benefit from ban of residue burning (willingness to pay)				
Small farmers	38	306	489,600	NA
Large farmers	36	295	5.4 million	NA
Welfare benefit from the protection of remaining hedges (willingness to pay)				
Small and large farmers	6.8	56	89,600	NA
Avoided damages from enhanced carbon sequestration and reduced GHG emissions				
Global society		541,500	4,390,000	
Enforcement and implementation costs				
Public authorities		15,050	122,000	NA
Net-benefits	**EANB/ha**	**NPV/ha**	**NPV district wide**	**BCR**
Farmers as a whole	**166**	**1343**	**16.9 million**	**3.8**
Georgian society	**NA**		**16.8 million**	**4.4**
Global society, including carbon sequestration			**21.2 million**	**5.3**

Assuming that: 8% and 92% of land in Dedoplistskaro district is cultivated respectively by small and large farmers (as revealed by the household survey undertaken for this study), and that large farmers adopt a mixed strategy of collecting half the straw and integrating the other half in the soil. The area cultivated with cereals 20,000 ha and 10,000 ha is burned annually in the business as usual scenario. Small farmers have less than 5 ha and large farmers have 5 ha or more.

Discussion and conclusion

Crop residue burning is an inexpensive and quick method to remove excess residue that facilitates planting and control pests and weeds. But there is a series of negative repercussions on ecosystems, some of which we have quantified here. The results suggest that it is about time to enforce a ban on crop residue burning because the benefits of retaining and using straw are higher than the additional costs of hiring machinery dealing with crop residues.

Moreover, the farming population have expressed preference for a ban on burning. Because fires easily spread across fields, their impacts cannot be effectively mitigated if farmers unilaterally decide to stop burning. It is a collective action problem. The economic potential of the nutrient and soil protection qualities embedded in straw should be exploited and not 'go up in smoke'. The avoidance of burning should ideally be adopted as part of a package of sustainable land management practices, including integrated pest management, conservation or no-tillage and frequent crop rotations. This will enhance soil biota, fauna and flora, food security and livelihoods in Dedoplistskaro, while favouring the mitigation and adaption to climate change.

Georgia could hereby make a serious contribution towards the achievement of UN Sustainable Development Goal 15 – Life on Land, carbon emissions reductions through the UNFCCC process and goals in the Convention on Biological Diversity.

References

Korontzi, S.; McCarty, J.; Loboda, T.; Kumar, S.; Justice, C.O. Global Distribution of Agricultural Fires from Three Years of MODIS Data; Global Biogeochem. Cy. 2006, 20, 2021; doi: 10.1029/2005GB002529. http://onlinelibrary.wiley.com/doi/10.1029/2005GB002529/full

This policy brief was authored by Vanja Westerberg and research undertaken with the support of the ELD initative.

For more information about our study and the findings, please contact:

- ELD Secretariat
  Email: info@eld-initiative.org