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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.

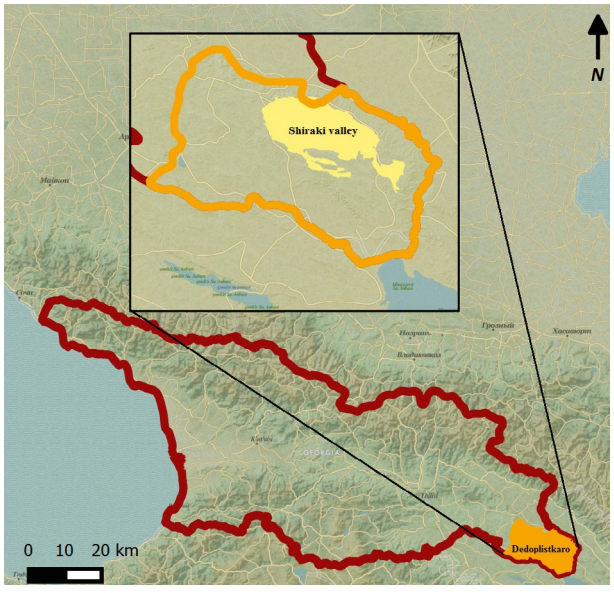
In the summer of 2015 large wildfires ravaged the Shiraki valley (43,000 ha) within the Dedoplistskaro district in Georgia (Figure 1). The valley is known as the breadbasket of Georgia, having provided the country with the lion's share of its wheat for centuries. With its deep soils with high humus content, 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. The Georgian Ministry of Environment

FIGURE 1

**Location of the Dedoplistkaro district of Georgia.**



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, analyzing 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 considers three valuation scenarios (Figure 2):

1. **A no-burn scenario** – characterised by voluntary decision of farmers to stop burning and instead retain straw in the soil to enhance soil nutrientes or collect and sell straw bales. It is assumed that either activity is done on 50% of the area cultivated with wheat and barley.
2. **Ban on burning scenario** – involving a ban on crop residue burning and subsequent decision by farmers to collect or retain straw in the soil.
3. **No change** – a simple continuation of the 'business as usual.'

The two first scenarios are valued relative to the baseline of no change.

## 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.

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 *It was not possible to find statistically robust leading variables that can predict future fire hazards. Therefore, to project the possible incidence of fire hazards from 2017 to 2026 in the absence of a policy change, normally distributed random numbers were drawn from a distribution characterised by the same mean (6917 ha) and standard deviation of the fire events in Dedoplistkaro from 2000 to 2015 (collected using MODIS data). Data from GIZ was used to establish a correlation between wildfire severity and windbreak mortality.*

FIGURE 2

**Outcomes for scenarios 1, 2 and 3.**

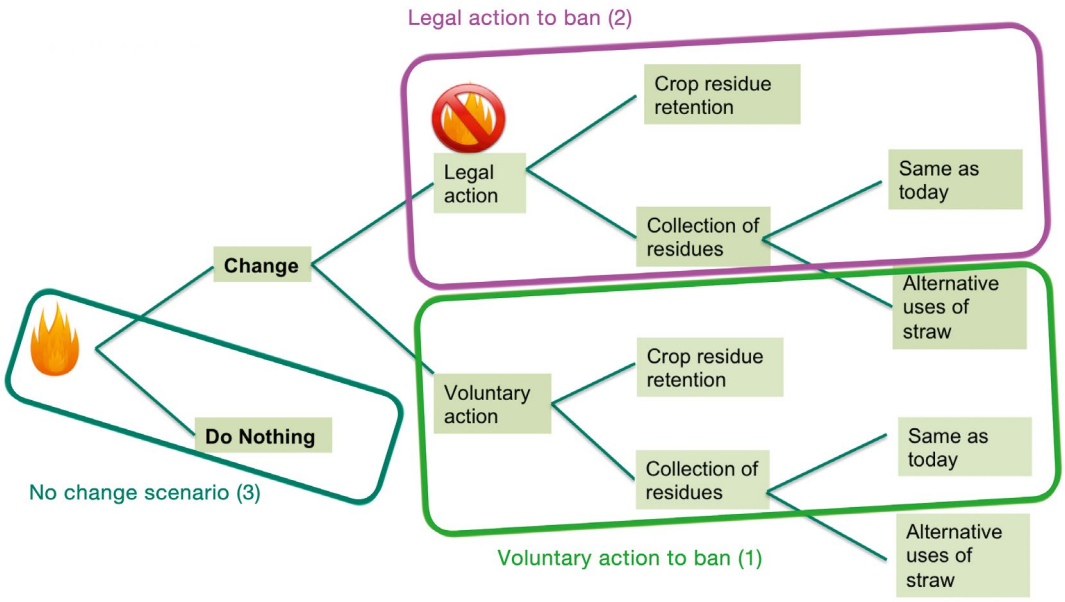


FIGURE 3

**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<br>Relative to what you pay today | 87 Lari/ha<br>0 Lari/ha | 80 Lari/ha<br>-7 Lari/ha | 110 Lari/ha<br>+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 farmers would experience a welfare loss of 14 GEL/ha/year from the disappearance of remaining windbreaks.

Furthermore, farmers demonstrated a willingness to pay an additional 41 GEL per ha of land cultivated in land registration fee to ensure a legally enforced ban on burning. 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 and soils against damages from fires originating on other farms. Farmers whose windbreaks were significantly affected by 2015 fires are willing to pay more.

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 4.7 million GEL (Figure 4), while the present value benefit of protecting remaining windbreaks is in the order of 0.6 million GEL.

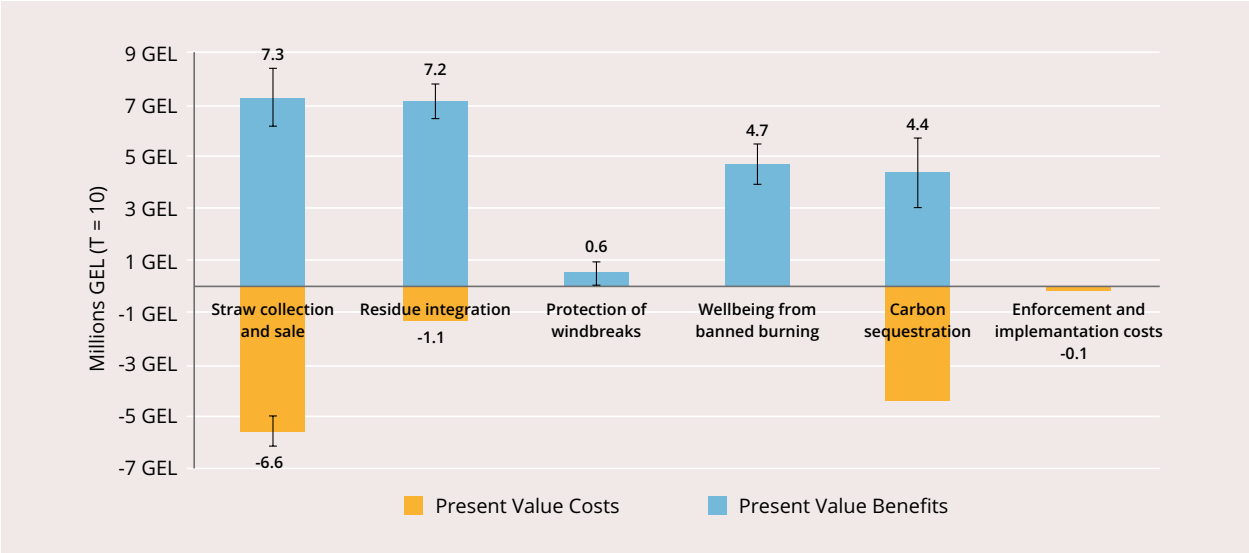
## Value of straw as fertilizer

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 will increase by between 11% and 23% if farmers stop residue burning and integrate straw into the soil instead. Farmers who burn every year have most to gain (23%) from terminating burning.

Using 2015 farmgate market prices for wheat and straw and accounting for the additional costs associated with hiring adapted farm machinery the results imply that Shiraki vally farmers will earn an additional income of between 77 GEL/ha and 163 GEL/ha year in present value terms, if they integrate straw residues into the soil instead of burning it. Figure 4 illustrates the aggregate net present values in Dedoplistkaro, highlighting that the aggregate benefits of integrating residues into the soil far outweight the costs of doing so.

### Straw for sale

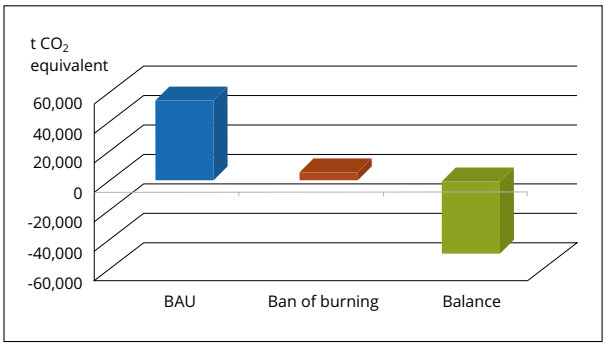
The burning of residues represents a lost economic opportunity in the sense that residues can no longer be used for fodder, fuel or animal bedding. Straw is sold at average of 75 GEL/ton (or 0.9 GEL/bale) in Dedoplistskaro. With a collection rate of 70%, 2.3 ton of straw per ha can be gathered in an average year, worth approximately 170 GEL/ha if sold in local markets. The machinery, space and time required to collect, compress and store straw, however, results in an additional cost of 130 GEL/ha. With these rev-enues and costs, the net-present value benefit to farmers is in the order of approximately 40 GEL/ha/year with an applied discount rate of 4%. Therefore, while there are large revenues to be earned from collecting straw, the high costs associ-ated with doing so render the net-benefits of doing so small (see figure 4).

### 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 49,000 tonnes $CO_2$ 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 $CO_2$eq (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 involves costs associated with raising awareness, the organisation of meetings and workshops with farmers, running information capaigns 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 126,000 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 of 1600 GEL per average farm using 2015 prices. In other words, farmers enjoy a return of 2.2 GEL per 1 GEL they spend if they voluntarily decide to stop burning. The aggregate benefit for all the farmers in the Dedoplistskaro district is in the order 7.7 million GEL for voluntary action to end burning in the Shiraki valley. This is a largely hypothetical scenario, as it is unlikely that all farmers would stop burning on a voluntary basis.

- If residue burning is prohibited by law across the district, windbreaks will be better protected and the risks of large scale catastrophic fires minimized. In that case, farmers will enjoy up to 3 GEL of benefits for every 1 GEL that they and the Georgian society need to spend to avoid burning and enforce a policy ban. Over a 10-year period, the ban on burning scenario result in a NPV benefit of 13.2 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 17.3 million GEL.

TABLE 1

**Net Present Value and Benefit Cost Ratio from ban on burning and voluntary adoption of no-burn (r=4%, #4820 farmers, T=10)**

| **Voluntary no-burn** | **NPV per farm** | **District-wide NPV** | **BCR** |
|---|---|---|---|
| Average farmer | 1600 (1431) | 7.7 million (6.9) | 2.2 |
| **Ban on burning** | **NPV per farm** | **District-wide NPV** | **BCR** |
| Average farmer* | 2700 (3498) | 13.2 million (10.7) | 3.0 |
| Georgian society | | 12.8 million (10.7) | 2.9 |
| Global society, incl. carbon sequestration benefits | | 17.3 million (15.8) | 5.6 |

*Standard deviation in brackets*
** Calculated for the average farmer with 3 ha of land.*

## 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*

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

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