Soil carbon sequestration under certified organic management in Albania, Serbia and Ukraine within SECO funded organic projects

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Soil carbon sequestration is an indicator for the climate change mitigation performance of agricultural land management. Already in the SECO-funded programme 'Higher Value-Added Trade from the Organic and the Dairy Sector in Ukraine (Quality FOOD Trade Program)', which started in 2020, soil carbon sequestration has been chosen as an impact indicator. The same applies for the SECO-funded project Organic Trade for Development (OT4D), which started in September 2019.

The rationale behind this is that there is evidence that organic agriculture on average builds up more soil carbon than conventional agriculture[1]. In the following, we present a rough estimation of this indicator in these projects, in order to understand the impact of the past development of organic agriculture in the period between 2011-2021, and for having a method to estimate progress at the end of the new Programme as well as a baseline in 2020[2].

Methodology

Based on the statistics of certified organic farmland (see table 1-3) and a rough formula, FiBL calculated the net soil carbon sequestration effect under certified organic management for the period from 2011 to 2021. Given the focus on crop production on these areas and the large areas concerned, FiBL suggests to use an average soil carbon sequestration value from the literature to get a gross picture on the sequestration potential without incurring huge measurement costs. This value is taken from a meta-analysis from 2012[3] mainly covering temperate zones, thus largely being adequate for the climatic situation in the project region.

The value chosen is the most conservative estimate referring to closed systems, i.e. reporting the sequestration performance without the danger of leakage via carbon mining on soils outside the project boundaries. The calculations are conservative in others aspects as well, as they assume a reconversion rate of 10% in each year, hidden in the reported net organic areas, accounted for by correcting the sequestration potential downwards by 10%. Furthermore, the reductions in organically cropped areas that can be observed in several years in the three countries are assumed to proportionally refer to areas that have been converted all along since 2011. These losses are thus accounted for by reducing the total sequestration performance till

[1] Gattinger, A., Muller, A., Häni, M., Skinner, C., Fliessbach, A., Buchmann, N., Mäder, P., Stolze, M., Smith, P., El-Hage Scialabba, N., Niggli, U., 2012, Enhanced top soil carbon stocks under organic farming, Proceedings of the National Academy of Sciences of the United States of America PNAS, 109 (44) 18226-18231

[2] These calculations rely on very general and uncertain assumptions. In consequence, please acknowledge the high uncertainty of these calculations and that the results may only serve as a very indicative illustration of the potential mitigation effect of the soil carbon sequestration in this project.

[3] Gattinger, A., Muller, A., Häni, M., Skinner, C., Fliessbach, A., Buchmann, N., Mäder, P., Stolze, M., Smith, P., El-Hage Scialabba, N., Niggli, U., 2012, Enhanced top soil carbon stocks under organic farming, Proceedings of the National Academy of Sciences of the United States of America PNAS, 109 (44) 18226-18231

the year before the year where the area reduction was observed by a corresponding reduction of the sequestration performance in proportion to these areas.

According to Gattinger et al 2012, the soil carbon sequestration rate for net zero input systems is 0.27 tC/ha/year (see Table 1). The definition of a net zero input system is via a threshold of reported nitrogen inputs corresponding to the manure of not more than 1 European Livestock Unit per hectare (for further explanation, see Gattinger et al. 2012, Methods Part). For comparison, we also report the literature value for all systems observed, i.e. including those that depend on external nutrient inputs: this value is 0.45tC/ha/y and thus about 70% higher than the value for net zero net input systems (Gattinger et al. 2012).

The value of 0.27tC/ha/year corresponds to 0.99 tCO2e/ha/year. Soil carbon sequestration shows a saturation dynamic, i.e. the sequestration rate goes down over the years and approaches zero after few decades, when a new higher equilibrium soil carbon concentration level is reached. It is thus assumed that the sequestration rate of 1tCO2e/ha/y applies in the first year and decreases linearly to 0tCO2e/ha/y over the course of 30 years (see Figure 1). This figure indicates how big the sequestration rate is after T years and illustrates the total sequestration incurred on one hectare after T years, which corresponds to the blue area.

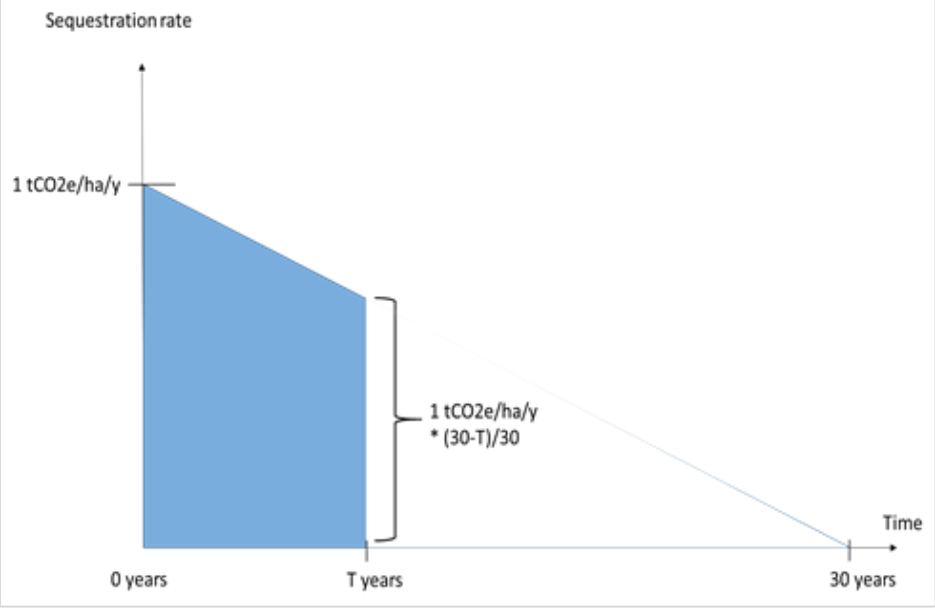

Figure 1: Sequestration rate over time

Formula 1: Sequestration rate after x years:

1tCO2e/ha/y(30-T)/30.*

Formula 2: Cumulative sequestration on 1 ha after T years:

1tCO2e/ha(30-T/2)/30*T.*

Calculation

Based on the area statistics, it is not clear since when the lost areas in Albania (2017 and 2019), in Serbia (2016, 2017 and 2020) and Ukraine (2016, 2017, 2020 and 2021) have been under organic management (see the excel-file for the hectares of these areas). Thus, FiBL assumes that the carbon accumulated till the respective year before this area loss is lost in proportion of these lost areas in relation to the total areas. See also the excel file for the total areas lost and the total areas converted to organic production up to the precedent years. These excel files then also display the corresponding area shares and the calculations to derive the total cumulative carbon sequestration accounting for these area reductions in the way just described above.

For Ukraine, the total cumulative sequestration from 2011 till 2015 is about 1'054'858 t CO_2eq (sum of the cumulative sequestration for each single year from 2011 to 2015, see the excel file and Table 1 below). Taking into consideration the correction by the area lost, i.e. total sequestration till 2017, this leads to 742'550 t CO2eq (=1'054'858tCO2e * (1-0.296), as this proportion of areas has been lost in these two years). In 2018 and 2019, again an increase in sequestration can be observed, followed by an additional loss due to reductions in organically cropped areas in the years 2020 and 2021 (see excel file and Table 1 below). Cumulated, all this leads to 1'146'391 tCO_2e. Multiplying the cumulative sequestration from 2011 to 2021 with the correction from reconversion (i.e. only accounting for 90% of this value), leads to 1'031'752 tCO_2e (=1'146'391 tCO2e * 0.9). Similar calculations apply for Albania and Serbia (see the excel file and Tables 2 and 3 below).

Table 1: Calculation of the cumulative soil carbon sequestration on the project areas in Ukraine from 2011 to 2021 (tCO_2e)

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**		
Hectares certified organic land (agricultural land), according to statistics, see Figure 1	270'320	272'850	393'400	400'764	410'550	381'173	289'000	309'100	467'980	462'225	422'299		
New organic certified area (=Year X – X-1)	0	2'530	120'550	7'364	9'786	-29'377*	-92'173*	20'100	158'800	-5755*	-39926*		**Cumulative Sequestration**
Total years under organic operation in 2021	11	10	9	8	7	6	5	4	3	2	1		**tCO2e**
Cumulative sequestration for each year separately till 2021 (tCO2e)**	0	21'083	922'208	51'057	60'510	-75'481	-236'827	75'040	452'808	-15'623	-108'385		**1'031'752**

*negative values due to areas lost, see the explanations above and the excel-file for further explanations on how this is accounted for

** The values report the cumulative sequestration on the areas newly converted in the year indicated till 2021. The total sequestration in the project is then the sum of these values over all years, multiplied by a correction factor of 0.9 see the last column (cf. the explanations above and the excel file).

Table 2: Calculation of the cumulative soil carbon sequestration on the project areas in Albania from 2011 to 2021 (tCO_2e)

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**		
Hectares certified organic land (agricultural land), according to statistics, see Figure 1	448	560	515	662	662	662	549	747	653	887	1094		
New organic certified area (=Year X – X-1)	0	112	-45*	147	0	0	-113*	198	-94*	234	207		**Cumulative Sequestration**
Total years under organic operation in 2021	11	10	9	8	7	6	5	4	3	2	1		**tCO2e**
Cumulative sequestration for each year separately till 2021 (tCO2e)**	0	933	-75	1'019	0	0	-320	737	-288	452	203		**2'396**

* and **: see notes for Table 1 above

Table 3: Calculation of the cumulative soil carbon sequestration on the project areas in Serbia from 2011 to 2021 (tCO_2e)

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**		
Hectares certified organic land (agricultural land), according to statistics, see Figure 1	6'237	6'340	8'288	9'548	15'298	14'358	13'423	19'255	21'266	19'317	23'527		
New organic certified area (=Year X – X-1)	0	103	1'888	1'320	5'750	-940*	-935*	5'831	2'011	-1'949*	4'210		**Cumulative Sequestration**
Total years under organic operation in 2021	11	10	9	8	7	6	5	4	3	2	1		**tCO2e**
Cumulative sequestration for each year separately till 2021 (tCO2e)**	0	858	14'443	9'151	35'555	-3'687*	-3'667*	21'771	5'731	-7'344*	4'140		**69'256**

* and **: see notes for Table 1 above

Conclusion

In **Ukraine**, between 2011 and 2021, the certified **organic land increased from 270'320 ha to 422'299 ha**. This corresponds to a net increase of 151'979 ha within 11 years. Between 2011 and 2021, organically cropped areas thus increased by more than 50%. The **net soil carbon sequestration effect of this has been about 1.0 million tons of CO2-equivalents**. For illustration, this could compensate for almost 2.5% of the greenhouse gas emissions from agriculture in Ukraine or for the emissions of about 1.7 million flights from Zurich to Kiev and back for 1 person, or about 520'000 such flights to New York and back. These impressive numbers are owed to the size of the project and the long project duration since 2011 - in 2021 it covered an area that corresponds to well more than the total cropland area of Switzerland.

In **Albania**, between 2011 and 2021, the **certified organic land increased from 448 ha to 1'094 ha**. This corresponds to a net increase of 646 ha within 11 years. Between 2011 and 2021, there was thus an almost 2.5-fold increase of organically cropped areas. The **net soil carbon sequestration effect of this has been about 2'200 tons of CO2-equivalents**. For illustration, this could compensate for about 0.04% of the greenhouse gas emissions from agriculture in Albania or for the emissions of about 5'200 flights from Zurich to Tirana and back for 1 person, or about 1'200 such flights to New York and back.

In **Serbia**, between 2011 and 2021, the **certified organic land increased from 6'237 ha to 23'527 ha**. This corresponds to a **net increase of 17'290 ha within 11 years**. Between 2011 and 2021, there was thus an almost a fourfold increase of organically cropped areas. The **net soil carbon sequestration effect of this has been about 70'000 tons of CO2-equivalents**. For illustration, this could compensate for about 1% of the greenhouse gas emissions from agriculture in Serbia or for the emissions of about 170'000 flights from Zurich to Belgrade and back for 1 person, or about 35000 such flights to New York and back.

<u>Important notice</u>: Be aware that these calculations rely on very general and uncertain assumptions. The high uncertainty of these calculations and that the results may only serve as a very indicative illustration of the potential mitigation effect of the soil carbon sequestration during the SECO-funded projects. Please do not communicate these numbers publicly and use them for internal use only. In particular, please do not communicate them with any qualifying statement regarding them, being e.g. "approved by FiBL".

Frick, 29.03.2023