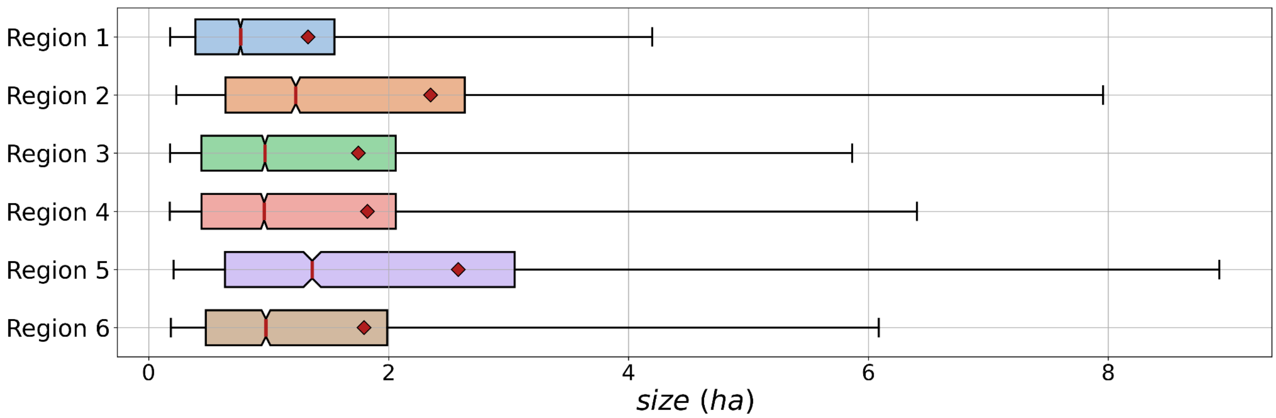

Fig. S1. Area distribution of the evaluated parcel for each study region. Area here is presented in hectares (ha), which is equal to 0.01 square kilometers (km^2).

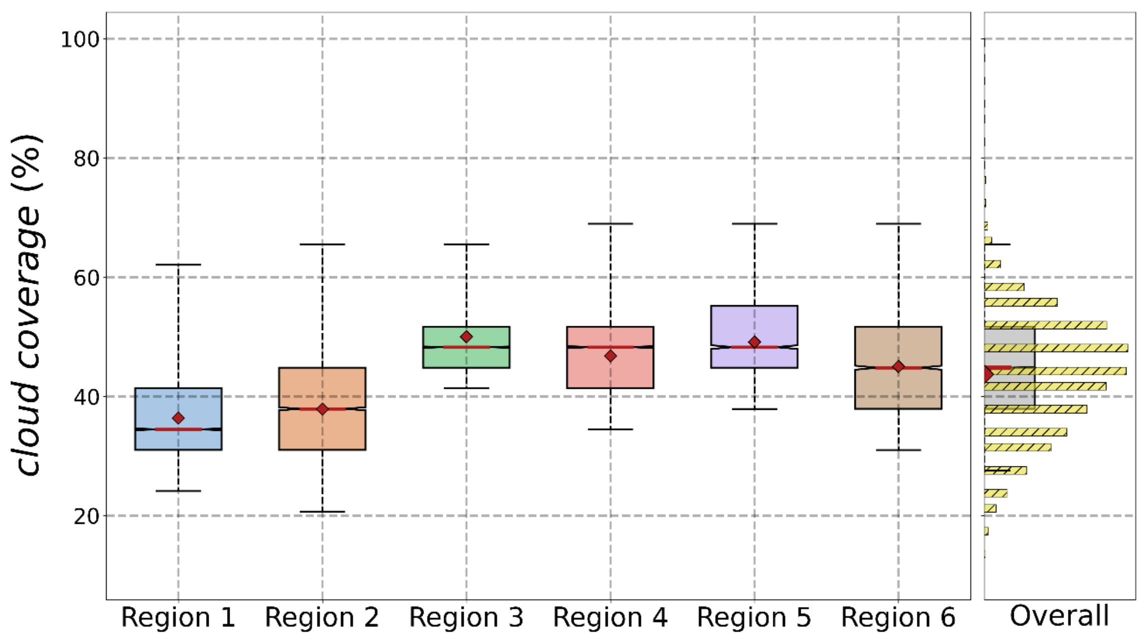

Fig. S2. Cloud coverage distribution of the pixel time series for each study region and overall. Cloud coverage for a time series is defined as the ratio of cloudy Sentinel-2 measurements to all available measurements.

In **Fig. S3** the MAE distributions of the hidden timestamps is analyzed in each region. Here, we observe relatively small errors between the ground truth and the SF predictions, which outperforms the others methods. More specifically, in Region 2 and Region 4 we observe the smallest MAE errors with mean value of 0.033, while LI and AI have around 0.039. In Region 1 the average MAE is approximately close to 0.039, while for the rest interpolation methodologies is over 0.045. Worst results are observed in Regions 5 and 6 with mean MAE of SF approach to be roughly 0.042, which is close to the interpolation methodologies, approximately a bit higher 0.044. This can be attributed to the smaller training sample from these regions, in comparison to the two first. However, the standard deviation acquired by SF in all regions is substantially smaller.

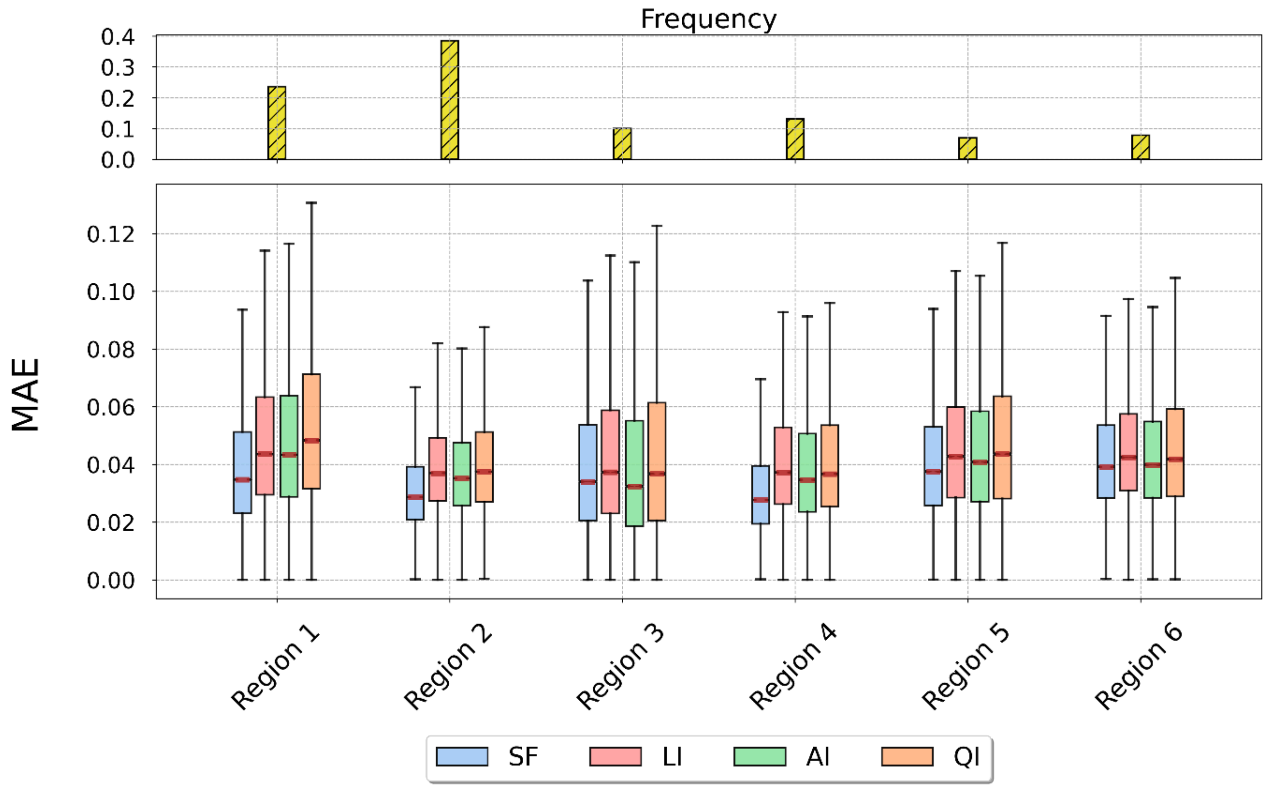

Fig. S3. The upper bar plot displays the frequency of each region, while the lower box plot shows the relevant values of MAE of masked NDVI values for the different interpolation methods on each region respectively.

In **Fig. S4** the mean and standard deviation of MAE is analyzed for each inference date. The figure illustrates also the percentage of pixels that experienced at least a 0.05 drop in NDVI value on each date. Sudden drops in NDVI are observed frequently from early June to mid-August, suggesting potential mowing or grazing events in Lithuanian grasslands during the summer months. Predicting steep NDVI drops poses a greater challenge, and consequently, the performance of the SF model tends to be poorer in such cases. Additionally, the middle plot depicts the distribution of NDVI differences between consecutive timestamps, providing insights into the variability of NDVI changes over time. Positive values during April and May indicate an increasing trend in the NDVI profile, while notably negative differences in mid-June and August suggest significant removal in total biomass, likely influenced by the statistical occurrence of mowing events during these periods.

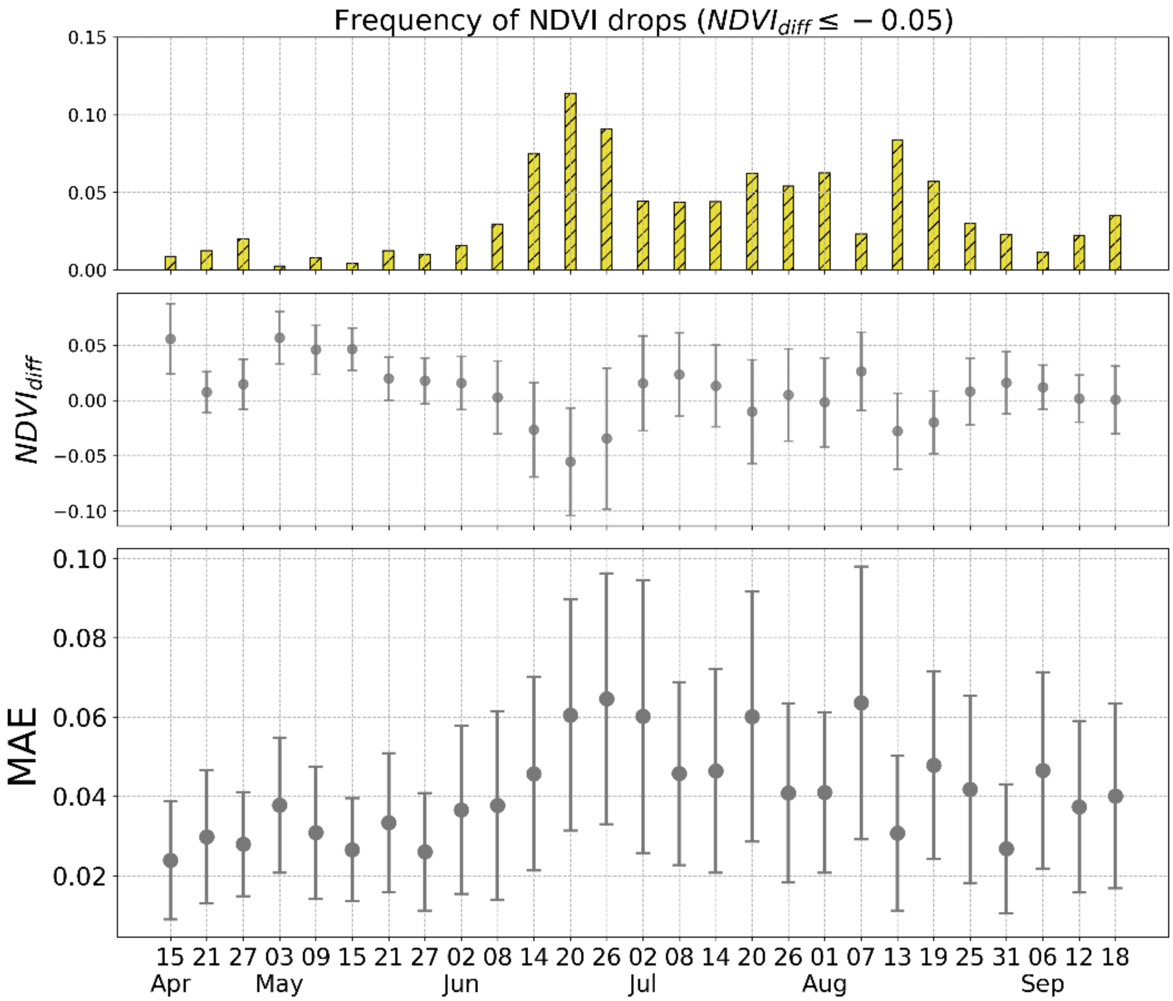

Fig. S4. The upper bar plot displays the frequency of NDVI drops (< 0.05), the middle plot depicts the distribution of NDVI differences between consecutive timestamps, while the lower box plot shows the relevant values of MAE on each date.

In **Fig. S5**, we compare the performance of the four different temporal interpolation methods under different cloud coverage scenarios. The analysis of the respective results under the different cloud coverage scenarios shows that, overall, SF outperformed the other methods, especially in cases of high cloud coverage. For example, in cases with less than 40% cloud coverage, all methods performed similarly, with SF yielding slightly better results with a MAE of 0.035, while AI, the second-best method, has a MAE of 0.041. However, as the number of cloudy timestamps in the time series increases, the MAE also increases for all methods. Specifically, when comparing the errors between the lowest and highest cloud coverage in the time series, there is an increase of 0.023 (from 0.034 to 0.057) in the mean value, while the standard deviation remains stable around 0.025 for the SF model. In contrast, for AI, the best-performing method among the other three, the mean value increases by 0.035 (from 0.04 to 0.075), and the standard deviation increases by 0.011 (from 0.027 to 0.038). These findings demonstrate the superior performance of SF, particularly in scenarios where the cloud coverage is high. In countries with extensive cloud coverage, long gaps in Sentinel-2 acquisitions can occur, sometimes lasting for months. Most interpolation methods have been proven effective for short-term cases, which are the most common situations, but their reliability decreases as gaps grow larger.

Moreover, the distribution of MAE for different lengths of consecutive missing values (see **Fig. S6**) highlighted that the SF model has relatively stable results, even with the absence of ten consecutive NDVI images. In the worst-case scenarios, the average MAE of SF fluctuates around 0.05 with a small standard deviation. Conversely, interpolation methods while performing well in small gaps (size less than 7) with an average MAE less than 0.04, similar to SF, struggled to predict extreme cases with over seven missing values in a row. In these cases, they usually underperformed, with MAE values exceeding 0.2 in several cases.

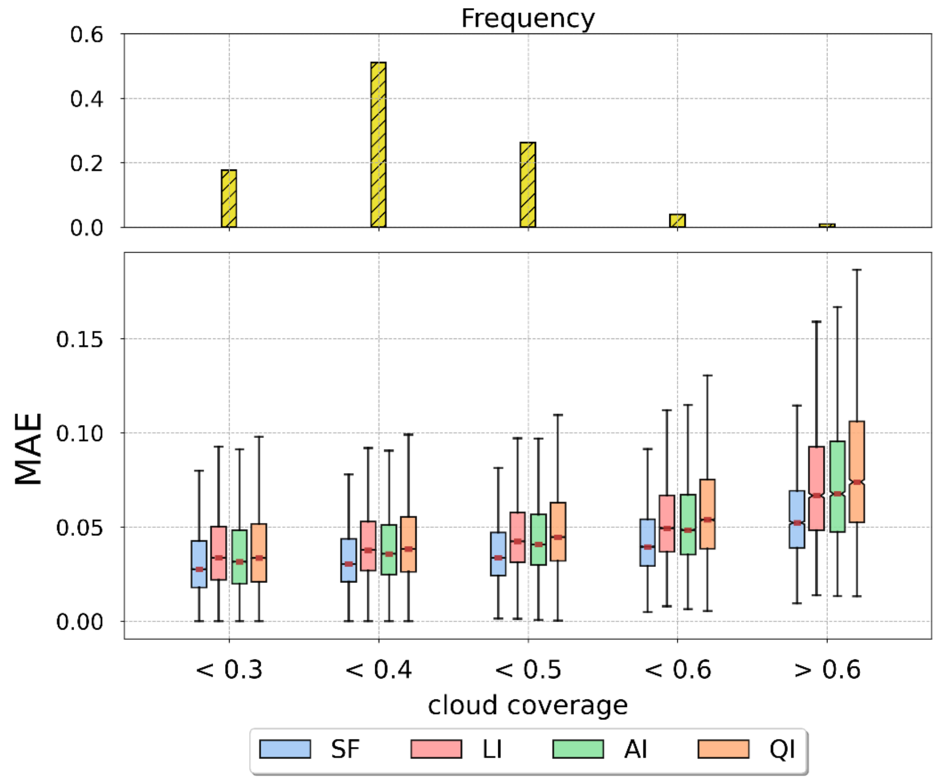

Fig. S5. The upper histogram shows the frequency of each cloud coverage scenario while the low box plot shows a comparison of the MAE for the different interpolation methods and the different cloud coverage scenarios.

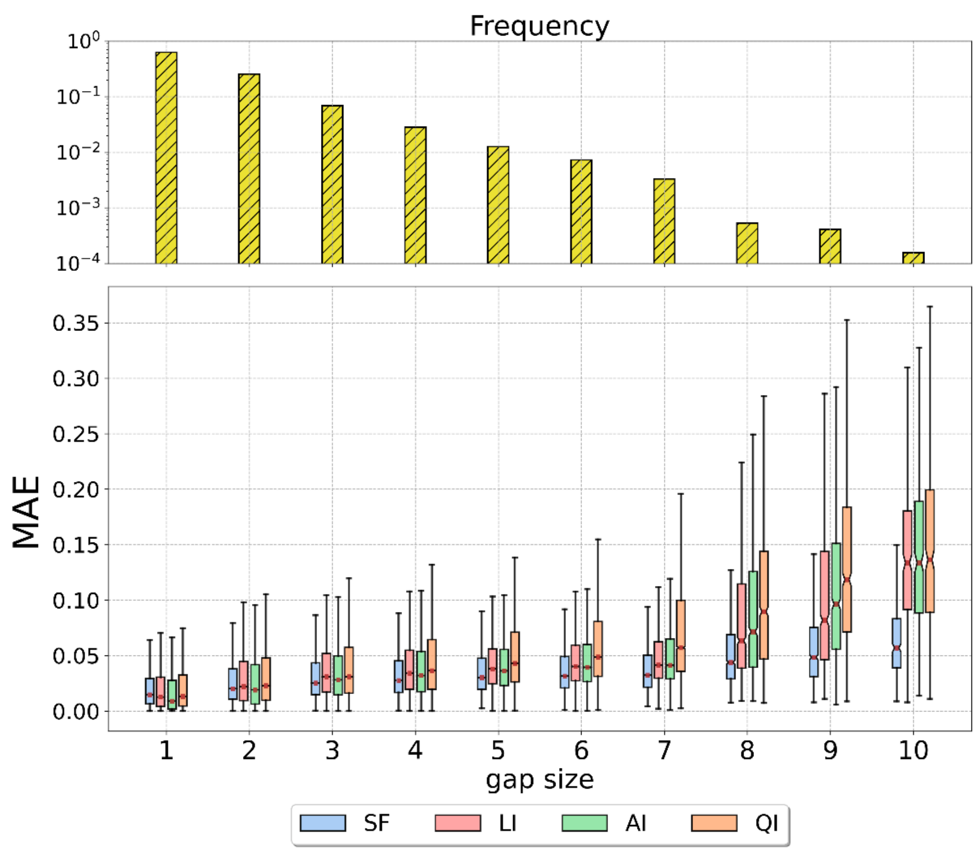

Fig. S6. The upper histogram shows the frequency of the number of consecutive missing values in the grasslands' NDVI time series while the low box plot shows a comparison of the MAE for the different interpolation methods and the different number of consecutive missing values (gap size).

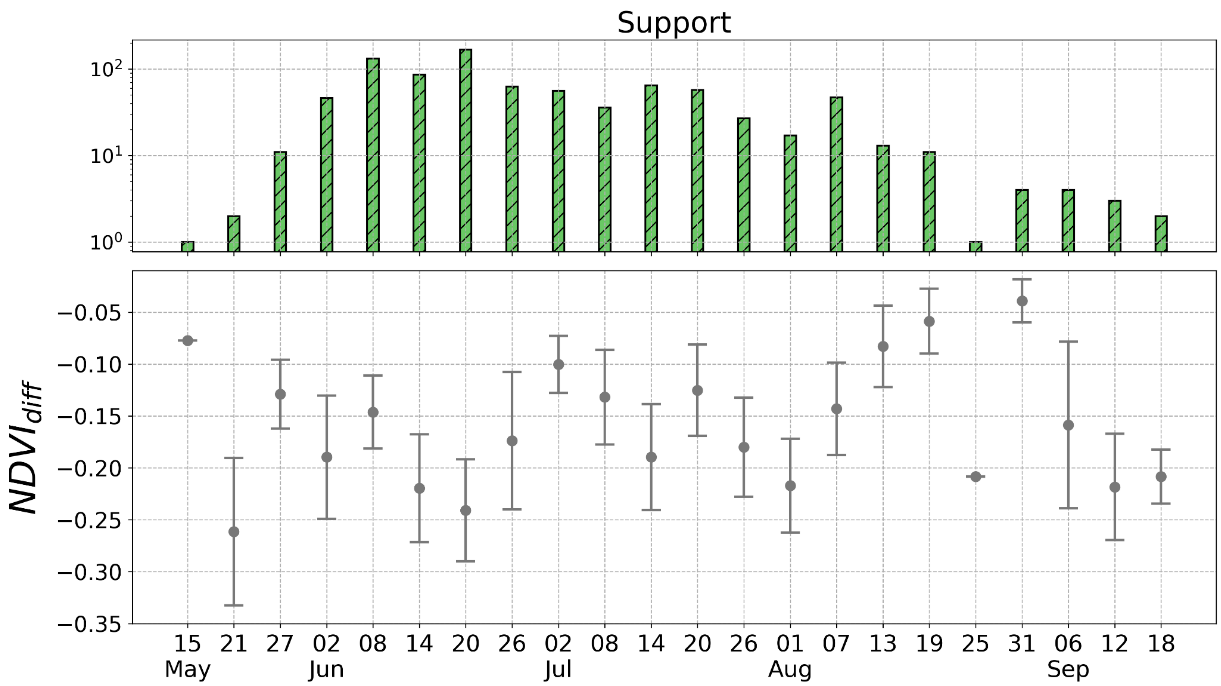

Fig. S7. Temporal distribution of mowing events assigned in 6-day buckets based on the closest reference date (upper plot) and distribution of NDVI differences for the corresponding timestamps (lower plot).

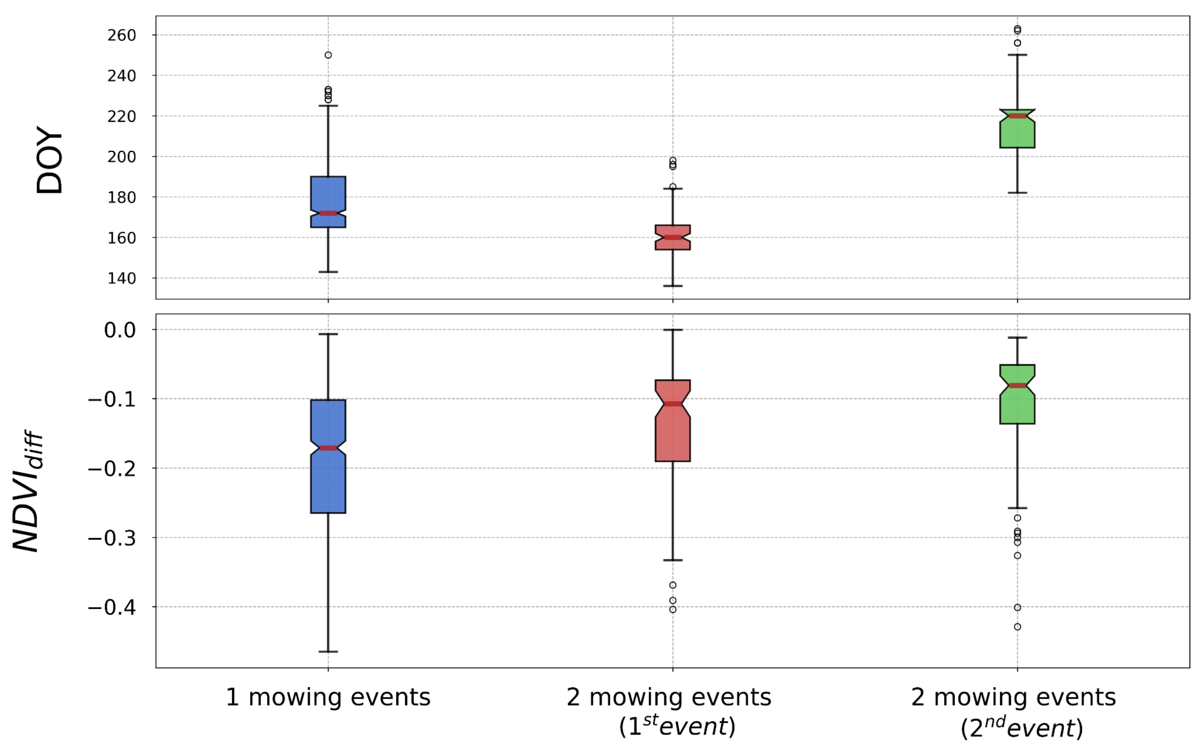

Fig. S8. Distribution of NDVI differences and corresponding number of mowing events. The upper plot shows the distribution of the day of the year when mowing events occurred. The lower plot illustrates the distribution of NDVI differences for each mowing event, highlighting the intensity of NDVI changes associated with these events.

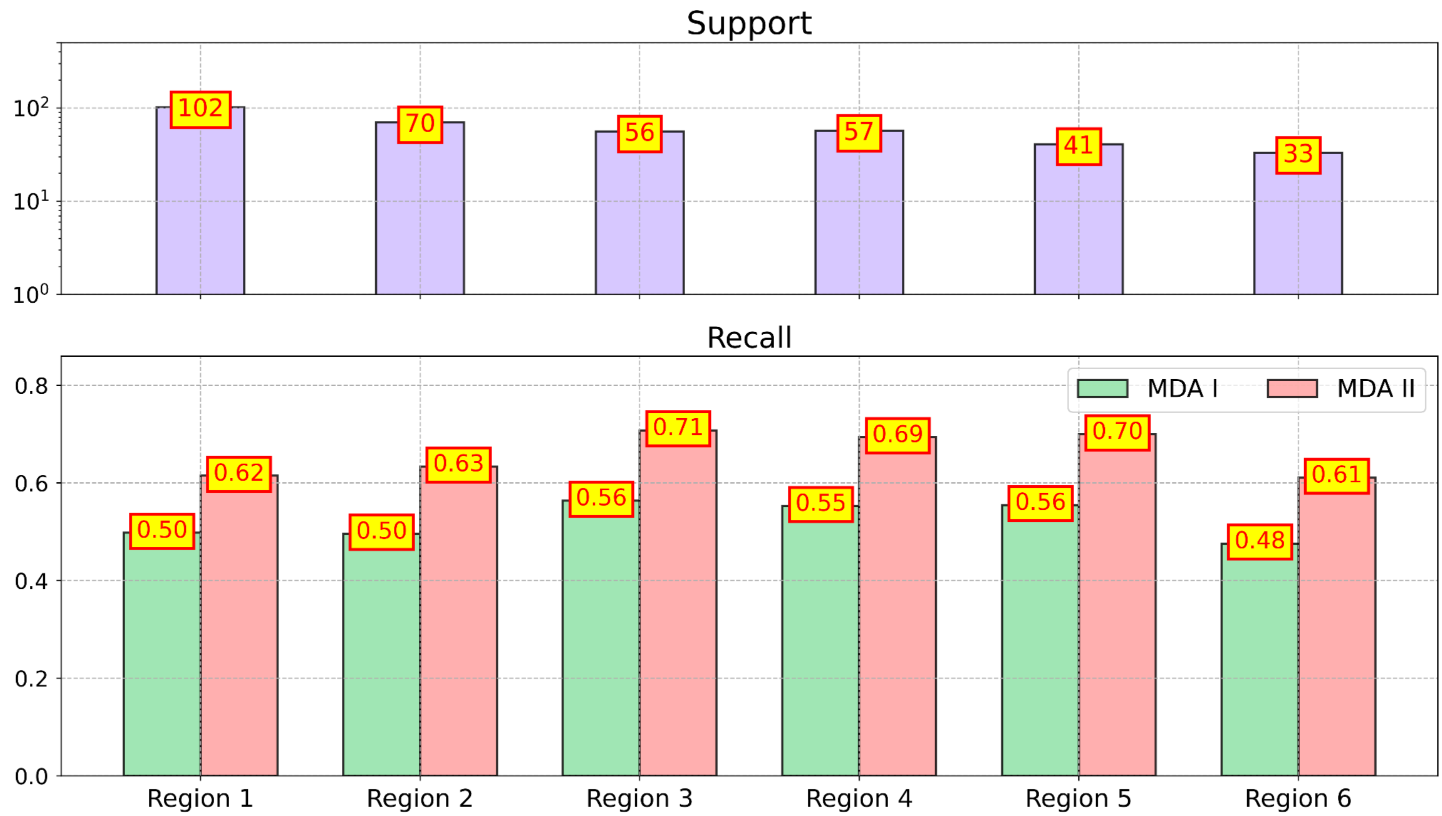

Fig. S9. Spatial distribution of the number of artificially masked mowing events detected (i.e., recall) for the different MDA over the different regions of the study.

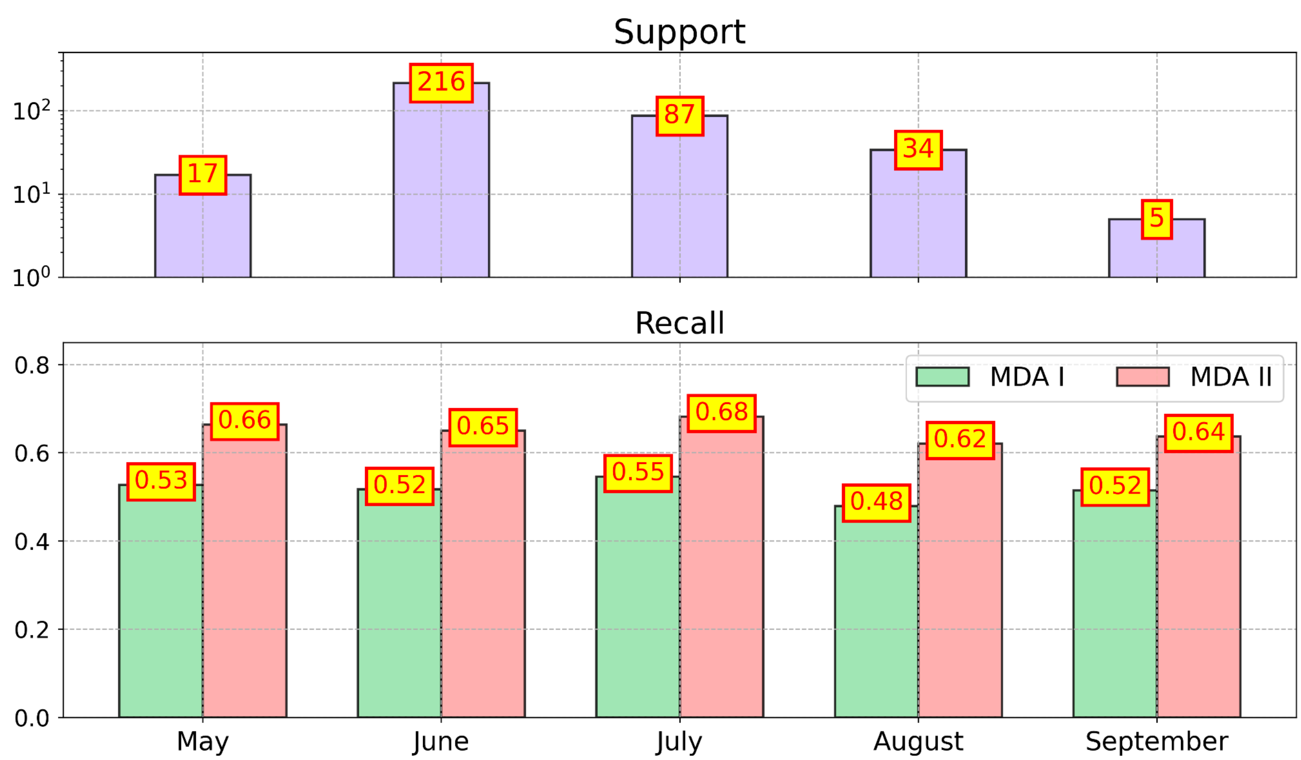

Fig. S10. Temporal distribution of the number of artificially masked mowing events detected (i.e., recall) for the different MDA over the different months of the evaluated period.

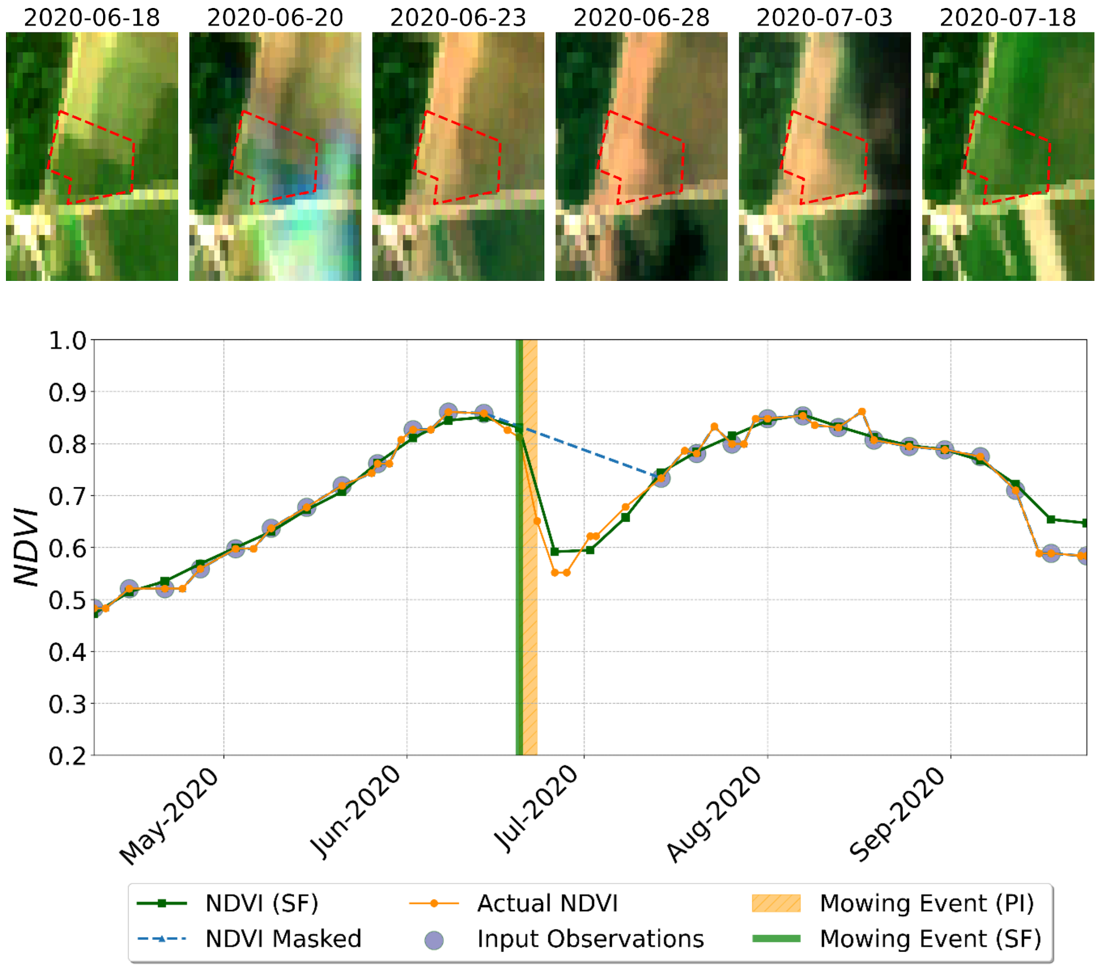

Fig. S11. NDVI reconstruction example related to a hidden mowing event. Upper box shows the actual RGB images captured from S2. In the lower box, blue dots show input NDVI values, the green line represents the SF predictions, and the orange line shows the actual.

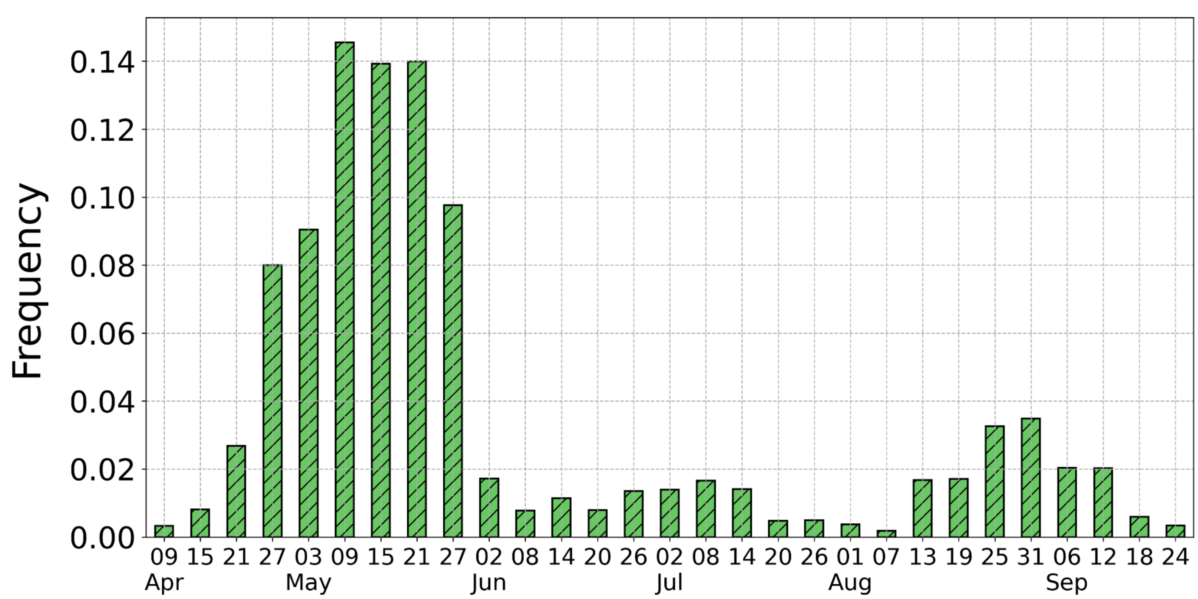

Fig. S12. Frequency of extended gaps on each date. Extended gaps are considered cases of pixels in a Sentinel-2 image that have been masked out due to cloud coverage for at least the three previous acquisitions.

Table S1
Recall and precision for grassland event detection based on start event date.

Algorithm	Interpolation	tolerance = 3 days		tolerance = 6 days		tolerance = 9 days		tolerance = 12 days	
		Recall	Precision	Recall	Precision	Recall	Precision	Recall	Precision
MDA I	-	0.556	0.502	0.663	0.599	0.705	0.637	0.755	0.717
	LI	0.500	0.556	0.627	0.697	0.657	0.731	0.719	0.800
	AI	0.502	0.566	0.635	0.716	0.655	0.750	0.712	0.803
	QI	0.413	0.439	0.631	0.672	0.687	0.730	0.732	0.800
	SF	0.507	0.649	0.662	0.847	0.703	0.899	0.749	0.928
MDA II	-	0.547	0.524	0.654	0.627	0.695	0.666	0.762	0.730
	LI	0.473	0.628	0.577	0.766	0.601	0.798	0.635	0.843
	AI	0.499	0.614	0.636	0.783	0.658	0.811	0.696	0.857
	QI	0.458	0.556	0.642	0.780	0.670	0.815	0.707	0.859
	SF	0.509	0.610	0.692	0.830	0.736	0.882	0.770	0.923

Table S2
Recall and precision for grassland event detection based on end event date.

Algorithm	Interpolation	tolerance = 3 days		tolerance = 6 days		tolerance = 9 days		tolerance = 12 days	
		Recall	Precision	Recall	Precision	Recall	Precision	Recall	Precision
MDA I	-	0.486	0.439	0.677	0.611	0.722	0.651	0.781	0.726
	LI	0.505	0.561	0.634	0.705	0.665	0.740	0.731	0.813
	AI	0.507	0.571	0.650	0.733	0.678	0.765	0.727	0.819
	QI	0.451	0.479	0.669	0.729	0.714	0.759	0.753	0.811
	SF	0.479	0.613	0.669	0.836	0.717	0.881	0.777	0.926
MDA II	-	0.498	0.477	0.695	0.666	0.727	0.706	0.759	0.785
	LI	0.480	0.637	0.590	0.783	0.614	0.815	0.640	0.849
	AI	0.500	0.616	0.656	0.808	0.682	0.840	0.700	0.861
	QI	0.492	0.598	0.673	0.817	0.695	0.845	0.709	0.862
	SF	0.513	0.615	0.695	0.824	0.729	0.866	0.764	0.916

Table S3
Recall and precision for grassland event detection based on median event date.

Algorithm	Interpolation	tolerance = 3 days		tolerance = 6 days		tolerance = 9 days		tolerance = 12 days	
		Recall	Precision	Recall	Precision	Recall	Precision	Recall	Precision
MDA I	-	0.559	0.504	0.665	0.601	0.723	0.653	0.753	0.698
	LI	0.519	0.577	0.624	0.695	0.668	0.743	0.725	0.807
	AI	0.519	0.585	0.638	0.720	0.680	0.766	0.718	0.810
	QI	0.432	0.459	0.653	0.694	0.707	0.752	0.737	0.805
	SF	0.545	0.671	0.675	0.863	0.715	0.914	0.753	0.934
MDA II	-	0.548	0.525	0.660	0.632	0.711	0.682	0.769	0.737

	LI	0.491	0.651	0.580	0.769	0.614	0.815	0.638	0.847
	AI	0.522	0.643	0.640	0.788	0.676	0.832	0.702	0.864
	QI	0.479	0.582	0.651	0.792	0.687	0.835	0.710	0.863
	SF	0.533	0.639	0.701	0.840	0.749	0.897	0.773	0.927

Table S4

MAE and R^2 on masked inference NDVI timestamps for different combinations of the SF model configuration. The highest value of each metric is printed in bold.

Conv1D Filters	Kernel Size	MaxPooling Size	LSTM Units	FC Units	Total params	MAE	R^2
-	-	-	16	[16, 8]	28,945	0.0423	0.849
-	-	-	32	[16, 8]	70,417	0.0421	0.851
-	-	-	16	[32, 16]	49,441	0.0425	0.849
-	-	-	32	[32, 16]	107,553	0.0425	0.848
[8, 16]	3	3	-	[16, 8]	23,057	0.0449	0.834
[8, 16]	5	5	-	[16, 8]	14,993	0.0452	0.832
[8, 16]	3	3	16	[16, 8]	47,121	0.0419	0.852
[8, 16]	5	5	16	[16, 8]	39,057	0.0413	0.855
[8, 16]	3	3	32	[16, 8]	88,593	0.0416	0.854
[8, 16]	5	5	32	[16, 8]	80,529	0.0414	0.855
[8, 16]	3	3	-	[32, 16]	47,705	0.0456	0.830
[8, 16]	5	5	-	[32, 16]	28,449	0.0457	0.829
[8, 16]	**3**	**3**	**16**	**[32, 16]**	**82,337**	**0.0364**	**0.885**
[8, 16]	5	5	16	[32, 16]	66,081	0.0366	0.885
[8, 16]	3	3	32	[32, 16]	140,449	0.0371	0.882
[8, 16]	5	5	32	[32, 16]	124,193	0.0375	0.878
[16, 32]	3	3	-	[16, 8]	51,089	0.0454	0.831
[16, 32]	5	5	-	[16, 8]	34,961	0.0455	0.829
[16, 32]	3	3	16	[16, 8]	75,153	0.0405	0.861
[16, 32]	5	5	16	[16, 8]	59,025	0.0411	0.857
[16, 32]	3	3	32	[16, 8]	116,625	0.0402	0.864
[16, 32]	5	5	32	[16, 8]	100,497	0.0405	0.861
[16, 32]	3	3	-	[32, 16]	91,169	0.0457	0.829
[16, 32]	5	5	-	[32, 16]	58,657	0.0458	0.828
[16, 32]	3	3	16	[32, 16]	128,801	0.0392	0.869
[16, 32]	5	5	16	[32, 16]	96,289	0.0396	0.865
[16, 32]	3	3	32	[32, 16]	186,913	0.0399	0.866
[16, 32]	5	5	32	[32, 16]	154,401	0.0401	0.863

Table S5

MAE and R^2 on masked inference NDVI timestamps for different training weight parameters (w_α, w_β) of the best SF model configuration. The highest value of each metric is printed in bold.

w_α	w_β	MAE	R^2
0.25	0.75	0.0403	0.863
0.25	1	0.0409	0.858
0.5	0.75	0.0399	0.862

0.5	1	0.0401	0.862
0.75	**0.25**	**0.0364**	**0.885**
0.75	0.5	0.0368	0.884
0.75	1	0.0389	0.871
1	0.25	0.0371	0.881
1	0.5	0.0382	0.874
1	1	0.0396	0.865

Table S6
MAE on masked inference NDVI timestamps of the SF model for different combinations of training regions.

Training Regions	Region 1	Region 2	Region 3	Region 4	Region 5	Region 6	Total	Training Pixels
Region 1	0.0396	0.0376	0.0514	0.0410	0.0461	0.0481	**0.0413**	408,132
Region 2	0.0480	0.0320	0.0506	0.0412	0.0479	0.0506	**0.0414**	184,452
Region 3	0.0524	0.0429	0.0423	0.0437	0.0491	0.0547	**0.0466**	68,18
Region 4	0.0495	0.0398	0.0521	0.0336	0.0478	0.0508	**0.0439**	158,419
Region 5	0.0578	0.0452	0.0590	0.0475	0.0444	0.0553	**0.0506**	49,377
Region 6	0.0528	0.0404	0.0608	0.0418	0.0501	0.0467	**0.0467**	114,742
(Region 1, Region 2)	0.0397	0.0316	0.0487	0.0394	0.0454	0.0466	**0.0383**	592,584
(Region 1, Region 3)	0.0411	0.0378	0.0442	0.0419	0.0460	0.0479	**0.0411**	476,312
(Region 1, Region 4)	0.0392	0.0351	0.0446	0.0320	0.0443	0.0452	**0.0381**	566,551
(Region 1, Region 5)	0.0400	0.0375	0.0497	0.0420	0.0430	0.0498	**0.0412**	457,509
(Region 1, Region 6)	0.0404	0.0366	0.0500	0.0390	0.0462	0.0440	**0.0404**	522,874
(Region 2, Region 3)	0.0484	0.0323	0.0408	0.0395	0.0443	0.0491	**0.0400**	252,632
(Region 2, Region 4)	0.0465	0.0320	0.0466	0.0336	0.0437	0.0459	**0.0390**	342,871
(Region 2, Region 5)	0.0482	0.0315	0.0475	0.0413	0.0405	0.0471	**0.0402**	233,829
(Region 2, Region 6)	0.0471	0.0312	0.0486	0.0374	0.0435	0.0419	**0.0392**	299,194
(Region 3, Region 4)	0.0473	0.0362	0.0400	0.0338	0.0448	0.0480	**0.0404**	226,599
(Region 3, Region 5)	0.0537	0.0441	0.0412	0.0435	0.0429	0.0506	**0.0464**	117,557
(Region 3, Region 6)	0.0497	0.0393	0.0408	0.0404	0.0448	0.0439	**0.0428**	182,922
(Region 4, Region 5)	0.0496	0.0371	0.0495	0.0341	0.0419	0.0490	**0.0422**	207,796
(Region 4, Region 6)	0.0482	0.0376	0.0483	0.0332	0.0472	0.0444	**0.0418**	273,161
(Region 5, Region 6)	0.0506	0.0398	0.0523	0.0418	0.0427	0.0444	**0.0444**	164,119
(Region 1, Region 2, Region 3)	0.0398	0.0321	0.0416	0.0389	0.0435	0.0455	**0.0376**	660,764
(Region 1, Region 2, Region 4)	0.0407	0.0324	0.0453	0.0329	0.0463	0.0467	**0.0378**	751,003
(Region 1, Region 2, Region 5)	0.0404	0.0319	0.0475	0.0396	0.0411	0.0459	**0.0382**	641961
(Region 1, Region 2, Region 6)	0.0390	0.0317	0.0478	0.0375	0.0453	0.0430	**0.0376**	707,326
(Region 1, Region 3, Region 4)	0.0404	0.0360	0.0421	0.0330	0.0438	0.0460	**0.0386**	634,731
(Region 1, Region 3, Region 5)	0.0397	0.0363	0.0411	0.0387	0.0416	0.0469	**0.0391**	525,689
(Region 1, Region 3, Region 6)	0.0399	0.0366	0.0406	0.0370	0.0441	0.0433	**0.0389**	591,054
(Region 1, Region 4, Region 5)	0.0394	0.0362	0.0420	0.0321	0.0389	0.0448	**0.0379**	615,928
(Region 1, Region 4, Region 6)	0.0390	0.0353	0.0454	0.0324	0.0434	0.0414	**0.0379**	681,293
(Region 1, Region 5, Region 6)	0.0412	0.0365	0.0488	0.0393	0.0436	0.0434	**0.0403**	572,251
(Region 2, Region 3, Region 4)	0.0497	0.0336	0.0426	0.0344	0.0455	0.0494	**0.0405**	411,051
(Region 2, Region 3, Region 5)	0.0487	0.0321	0.0403	0.0392	0.0409	0.0477	**0.0396**	302,009
(Region 2, Region 3, Region 6)	0.0476	0.0314	0.0393	0.0375	0.0420	0.0420	**0.0384**	367,374
(Region 2, Region 4, Region 5)	0.0467	0.0320	0.0468	0.0346	0.0422	0.0461	**0.0391**	392,248

(Region 2, Region 4, Region 6)	0.0487	0.0331	0.0457	0.0336	0.0444	0.0430	**0.0396**	457,613
(Region 2, Region 5, Region 6)	0.0463	0.0317	0.0468	0.0384	0.0400	0.0425	**0.0389**	348,571
(Region 3, Region 4, Region 5)	0.0480	0.0363	0.0398	0.0335	0.0398	0.0449	**0.0400**	275,976
(Region 3, Region 4, Region 6)	0.0466	0.0356	0.0421	0.0325	0.0442	0.0433	**0.0397**	341,341
(Region 3, Region 5, Region 6)	0.0513	0.0387	0.0416	0.0394	0.0419	0.0442	**0.0427**	232,299
(Region 4, Region 5, Region 6)	0.0478	0.0364	0.0477	0.0341	0.0405	0.0433	**0.0407**	322,538
Total	**0.0456**	**0.0357**	**0.0459**	**0.0376**	**0.0439**	**0.0463**	-	-
Linear Interpolation (All Regions)	0.0498	0.0403	0.0466	0.0427	0.0471	0.0465	0.0442	-
Sentinel-1/2 Fusion (All Regions)	0.0402	0.0319	0.0408	0.0326	0.0416	0.0432	0.0364	983,302

Table S7

Mowing detection performance (i.e., recall, precision and F1-score) calculated for different cloud coverage percentages (ccp) for the different mowing detection algorithms (MDA). The groups were divided using the mean ($\mu \simeq 0.4$) and standard deviation ($\sigma \simeq 0.1$) values of the cloud coverage distribution, which resembled a normal distribution.

Metric	Interpolation	ccp < μ − σ		μ − σ ≤ ccp < μ		μ ≤ ccp < μ + σ		ccp ≥ μ + σ	
		MDA I	MDA II	MDA I	MDA II	MDA I	MDA II	MDA I	MDA II
Recall	LI	0.740	0.690	0.737	0.632	0.707	0.633	0.701	0.608
	AI	0.731	0.709	0.721	0.691	0.705	0.709	0.699	0.671
	QI	0.729	0.714	0.711	0.721	0.758	0.721	0.721	0.667
	SF	0.787	0.789	0.745	0.755	0.747	0.789	0.735	0.754
Precision	LI	0.794	0.784	0.782	0.845	0.829	0.854	0.777	0.868
	AI	0.800	0.763	0.797	0.842	0.827	0.905	0.770	0.858
	QI	0.796	0.792	0.800	0.835	0.805	0.891	0.808	0.870
	SF	0.824	0.813	0.924	0.900	0.975	0.965	0.92	0.961
F1-Score	LI	0.766	0.734	0.759	0.723	0.763	0.727	0.737	0.715
	AI	0.764	0.735	0.757	0.759	0.761	0.795	0.733	0.753
	QI	0.761	0.751	0.753	0.774	0.781	0.797	0.762	0.755
	SF	0.805	0.801	0.825	0.821	0.846	0.868	0.817	0.845
Support		101		252		291		159	

Table S8

Mowing detection F1-score across varying numbers of training regions for the SF models, as detailed in Table S6. The values represent the mean and standard deviation of F1-scores for each mowing detection algorithm (MDA) evaluated on each region, using the reconstructed NDVI from the SF models trained with the specified number of regions.

Number of SF training regions	Evaluated Mowing Region	MDA I	MDA II
1	1	0.729 ± 0.038	0.737 ± 0.033
	2	0.698 ± 0.022	0.707 ± 0.037
	3	0.835 ± 0.057	0.844 ± 0.061
	4	0.827 ± 0.024	0.835 ± 0.018
	5	0.812 ± 0.023	0.850 ± 0.021
	6	0.639 ± 0.043	0.656 ± 0.042
	Total	**0.742 ± 0.036**	**0.758 ± 0.039**
2	1	0.749 ± 0.023	0.770 ± 0.029

	2	0.723 ± 0.028	0.749 ± 0.026
	3	0.882 ± 0.019	0.893 ± 0.043
	4	0.845 ± 0.028	0.853 ± 0.019
	5	0.840 ± 0.020	0.856 ± 0.017
	6	0.689 ± 0.030	0.682 ± 0.023
	Total	**0.773 ± 0.024**	**0.787 ± 0.022**
3	1	0.812 ± 0.024	0.815 ± 0.021
	2	0.767 ± 0.022	0.799 ± 0.028
	3	0.895 ± 0.010	0.911 ± 0.018
	4	0.858 ± 0.017	0.861 ± 0.014
	5	0.859 ± 0.020	0.866 ± 0.021
	6	0.746 ± 0.029	0.766 ± 0.028
	Total	**0.818 ± 0.016**	**0.827 ± 0.012**