

Impact of arable land abandonment on crop production losses in Ukraine during the armed conflict

Supplementary material

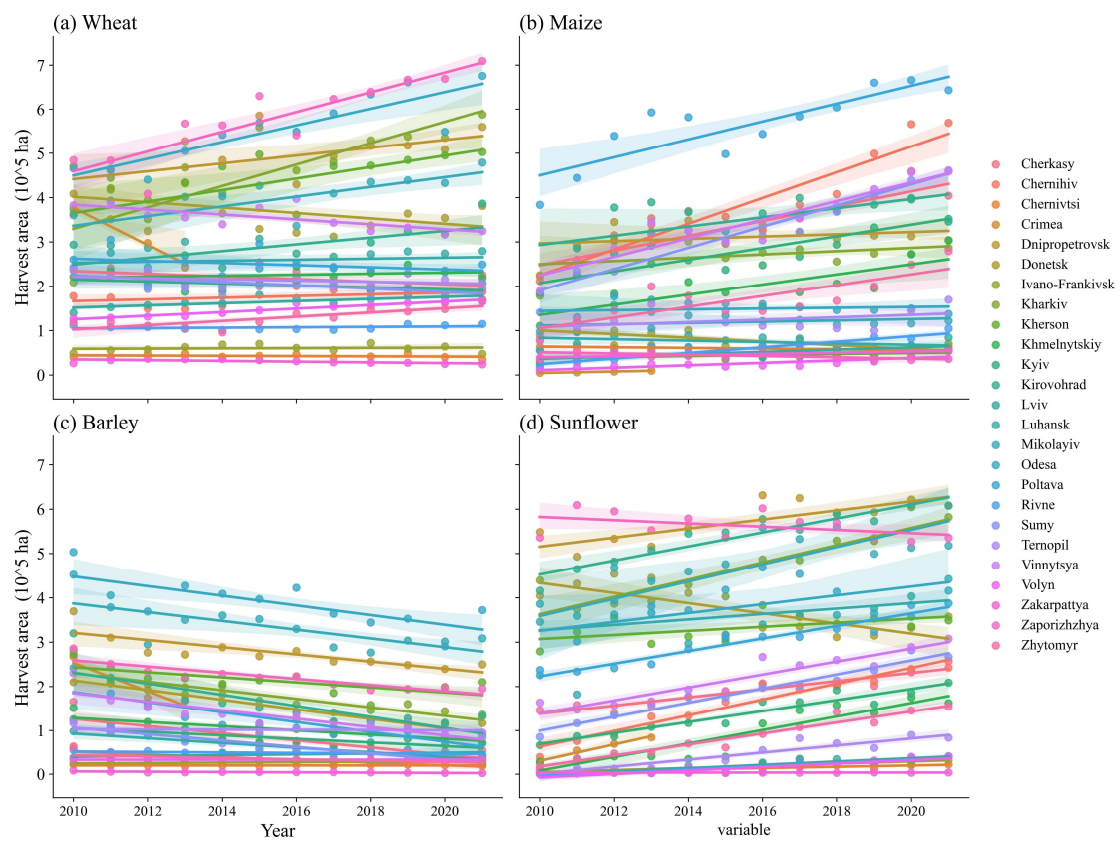


Figure S1. The changes of crop harvest area in states of Ukraine from 2010 to 2021.

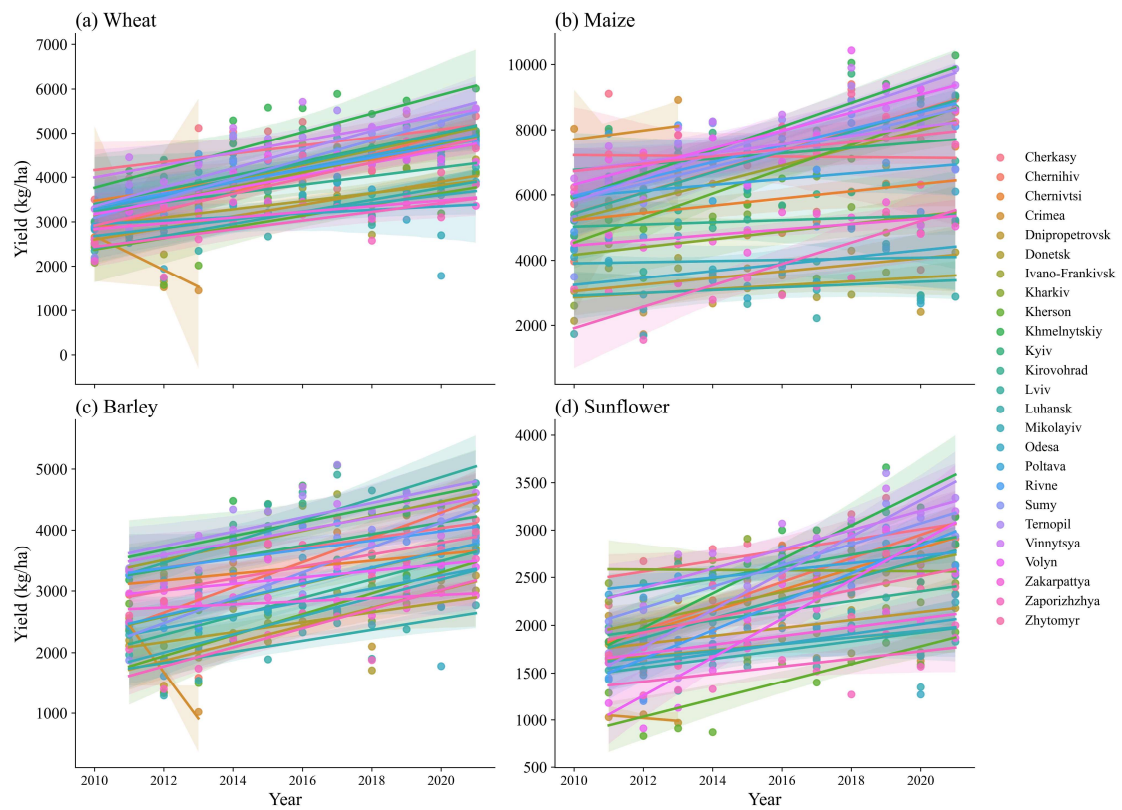


Figure S2. The changes of crop yield in states of Ukraine from 2010 to 2021.

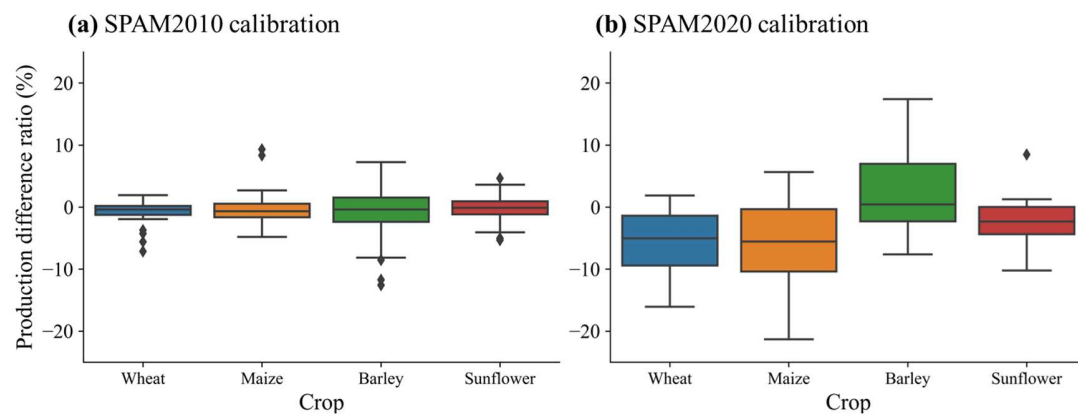


Figure S3. The crop production difference between the calibrated gridded and statistical data.

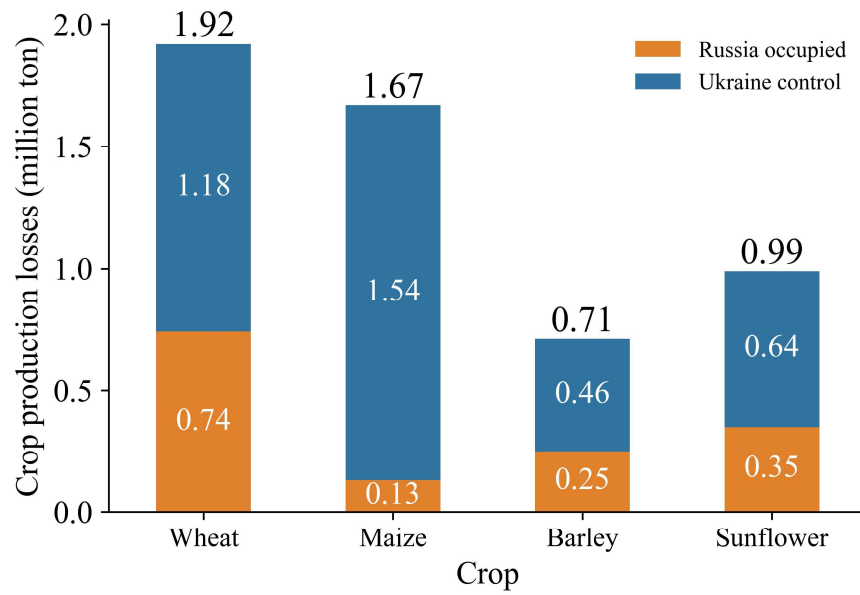
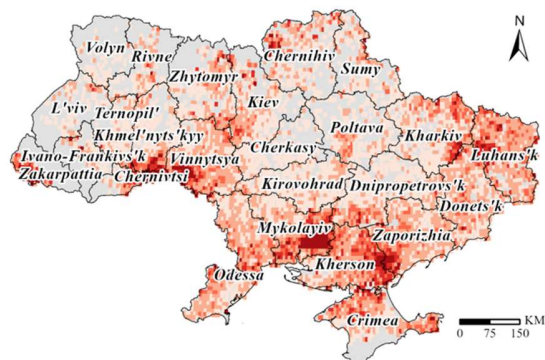
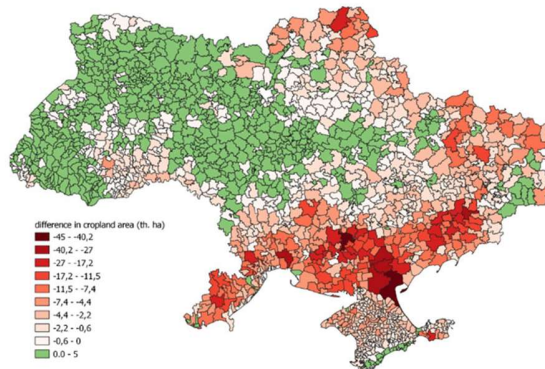


Figure S4. The crop production losses in the Ukraine controlled zones and Russia occupied zones.

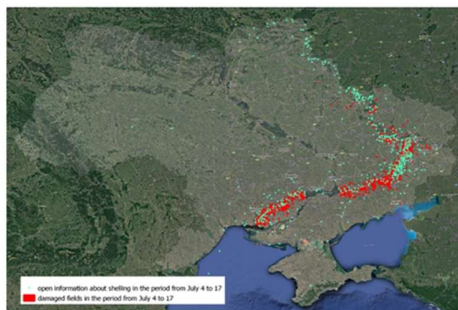
(a) This study



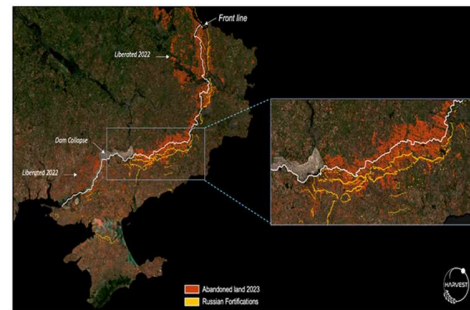
(b) Kussul et al., 2022



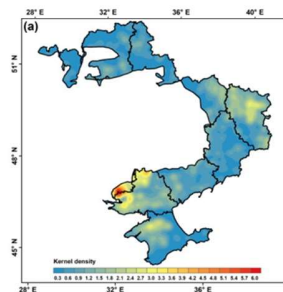
(c) Deininger et al., 2023



(d) Wagner et al., 2023



(e) Ma et al., 2022



(f) He et al., 2023

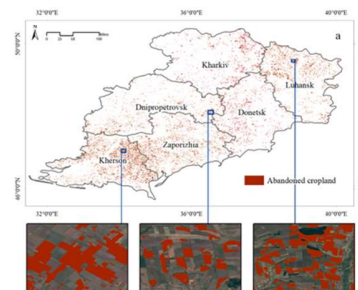


Figure S5. The comparison of abandoned cropland extraction results.

Table S1. Threshold of abandoned cropland extraction.

| State | Min | Median | Max | State | Min | Median | Max |
|------------------------|--------|--------|--------|---------------------|--------|--------|--------|
| Cherkasy | -0.097 | -0.094 | -0.094 | Luhansk | -0.214 | -0.213 | -0.212 |
| Chernihiv | -0.157 | -0.156 | -0.155 | Mikolayiv | -0.201 | -0.201 | -0.199 |
| Chernivtsi | -0.150 | -0.150 | -0.147 | Odesa | -0.143 | -0.143 | -0.142 |
| Crimea | -0.234 | -0.233 | -0.233 | Poltava | -0.166 | -0.164 | -0.162 |
| Dnipropetrovsk | -0.140 | -0.139 | -0.138 | Rivne | -0.121 | -0.121 | -0.120 |
| Donetsk | -0.147 | -0.146 | -0.146 | Sumy | -0.190 | -0.189 | -0.188 |
| Ivano-Frankivsk | -0.110 | -0.110 | -0.107 | Ternopil | -0.109 | -0.109 | -0.107 |
| Kharkiv | -0.150 | -0.150 | -0.149 | Vinnytsya | -0.139 | -0.138 | -0.137 |
| Kherson | -0.246 | -0.243 | -0.243 | Volyn | -0.095 | -0.095 | -0.093 |
| Khmelnyskiy | -0.115 | -0.113 | -0.112 | Zakarpattya | -0.206 | -0.202 | -0.202 |
| Kyiv | -0.112 | -0.112 | -0.109 | Zaporizhzhya | -0.234 | -0.233 | -0.231 |
| Kirovohrad | -0.140 | -0.140 | -0.139 | Zhytomyr | -0.123 | -0.120 | -0.120 |
| Lviv | -0.107 | -0.107 | -0.104 | | | | |

Table S2. Abandoned cropland ratio of Ukraine in 2022 (million ha).

| | Total | Ukraine control | Russia occupied |
|---------------|--------------|-----------------|-----------------|
| Upper | 2.40 (7.30%) | 1.48 (12.00%) | 0.92 (8.02%) |
| Median | 2.37 (7.22%) | 1.46 (11.90%) | 0.91 (7.94%) |
| Lower | 2.34 (7.14%) | 1.44 (11.82%) | 0.90 (7.89%) |

Table S3. The amount and ratio of crop production losses across Ukraine (million ton).

| | Threshold type | Total | Ukraine control | Russia occupied |
|-----------|----------------|---------------|-----------------|-----------------|
| Wheat | Upper | 1.94 (-9.19%) | 1.19 (-8.11%) | 0.75 (-11.69%) |
| | Median | 1.92 (-9.10%) | 1.18 (-8.03%) | 0.74 (-11.59%) |
| | Lower | 1.89 (-9.04%) | 1.16 (-7.96%) | 0.73 (-11.51%) |
| Maize | Upper | 1.70 (-7.56%) | 1.57 (-7.31%) | 0.13 (-12.73%) |
| | Median | 1.67 (-7.48%) | 1.54 (-7.24%) | 0.13 (-12.63%) |
| | Lower | 1.64 (-7.42%) | 1.52 (-7.18%) | 0.12 (-12.55%) |
| Barly | Upper | 0.71 (-9.63%) | 0.46 (-8.70%) | 0.25 (-12.03%) |
| | Median | 0.70 (-9.54%) | 0.46 (-8.61%) | 0.24 (-11.94%) |
| | Lower | 0.69 (-9.47%) | 0.45 (-8.53%) | 0.24 (-11.86%) |
| Sunflower | Upper | 1.00 (-8.75%) | 0.65 (-7.68%) | 0.35 (-11.78%) |
| | Median | 0.99 (-8.67%) | 0.64 (-7.61%) | 0.35 (-11.69%) |
| | Lower | 0.98 (-8.61%) | 0.64 (-7.55%) | 0.34 (-11.61%) |

The figures in parentheses represent the extent of crop production losses, while the percentages indicate the loss ratios of crop production within the region.

Table S4. Crop production of different countries during 2022 (million ton).

| | Wheat | Maize | Barley | Sunflower |
|-----------------|-------|-------|--------|-----------|
| Belgium | 1.85 | 0.50 | 0.37 | 0.00 |
| Croatia | 0.97 | 1.64 | 0.32 | 0.15 |
| Morocco | 2.71 | 0.04 | 0.70 | 0.03 |
| Tanzania | 0.08 | 5.90 | 0.02 | 1.15 |

These data were obtained from the Food and Agriculture Organization databased (<https://www.fao.org/faostat>).