Estimation of maize sowing dates from Sentinel 1&2 data, over South Piedmont

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EO for the assessment of actual sowing dates

Motivations

- Actual sowing calendars are a valuable information to increase the accuracy of models based on crop development .

- Analysis of the factors that can affect crop yield and agricultural production.

- Monitoring of agricultural practices at the field scale.

- Availability of remote sensing information on a wide range of wave-lenghts.

- High resolution sensors and high frequency temporal coverage.

Technologies

GOALS

- Assessment of *maize sowing dates* at the field scale.

- Exploiting the potential of *Sentinel Constellation* for agricultural applications.

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- Agricultural area in South Piedmont (Italy), widely equipped for irrigation.

- Pilot area: 28 municipalities (about 30x30 km).

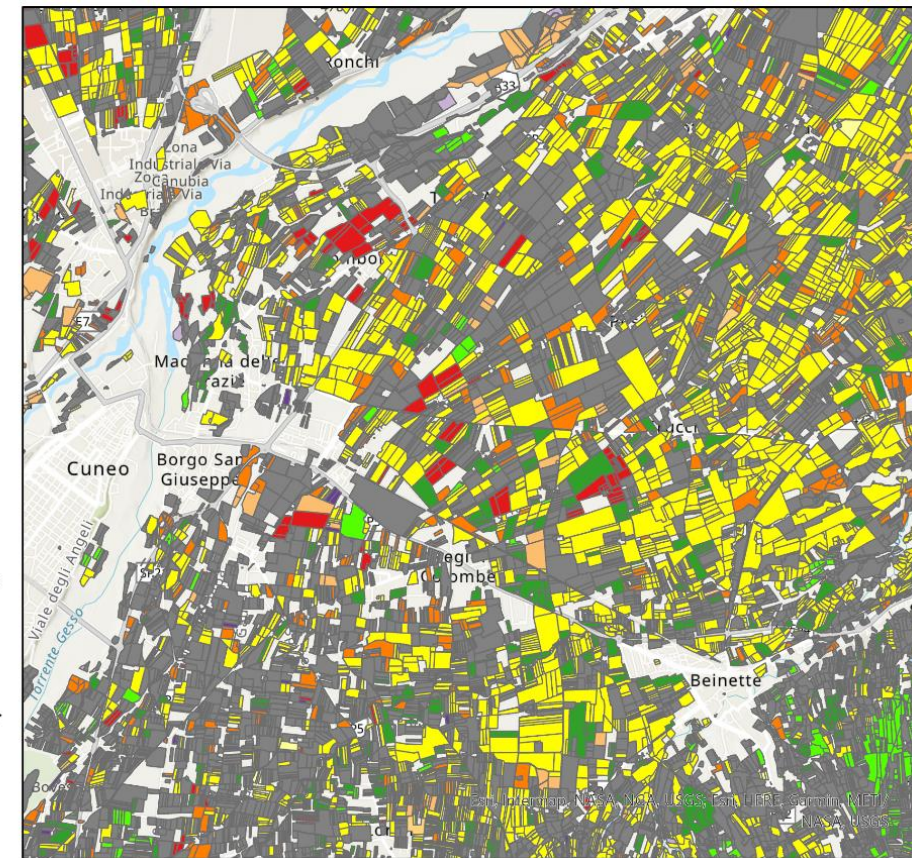- Elevation of the agricultural area: 330 m – 560 m (above the sea level).

CROP DATA

Annual shapefiles of crop distribution from the cadastral geodatabase of Regione Piemonte (2015-present).
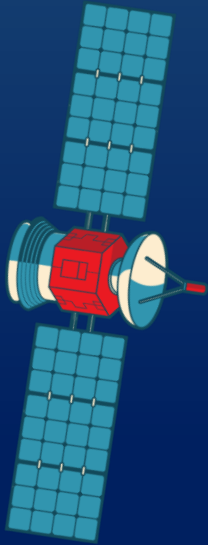
PILOT CROP → *MAIZE* (66% oh harvested cereals)
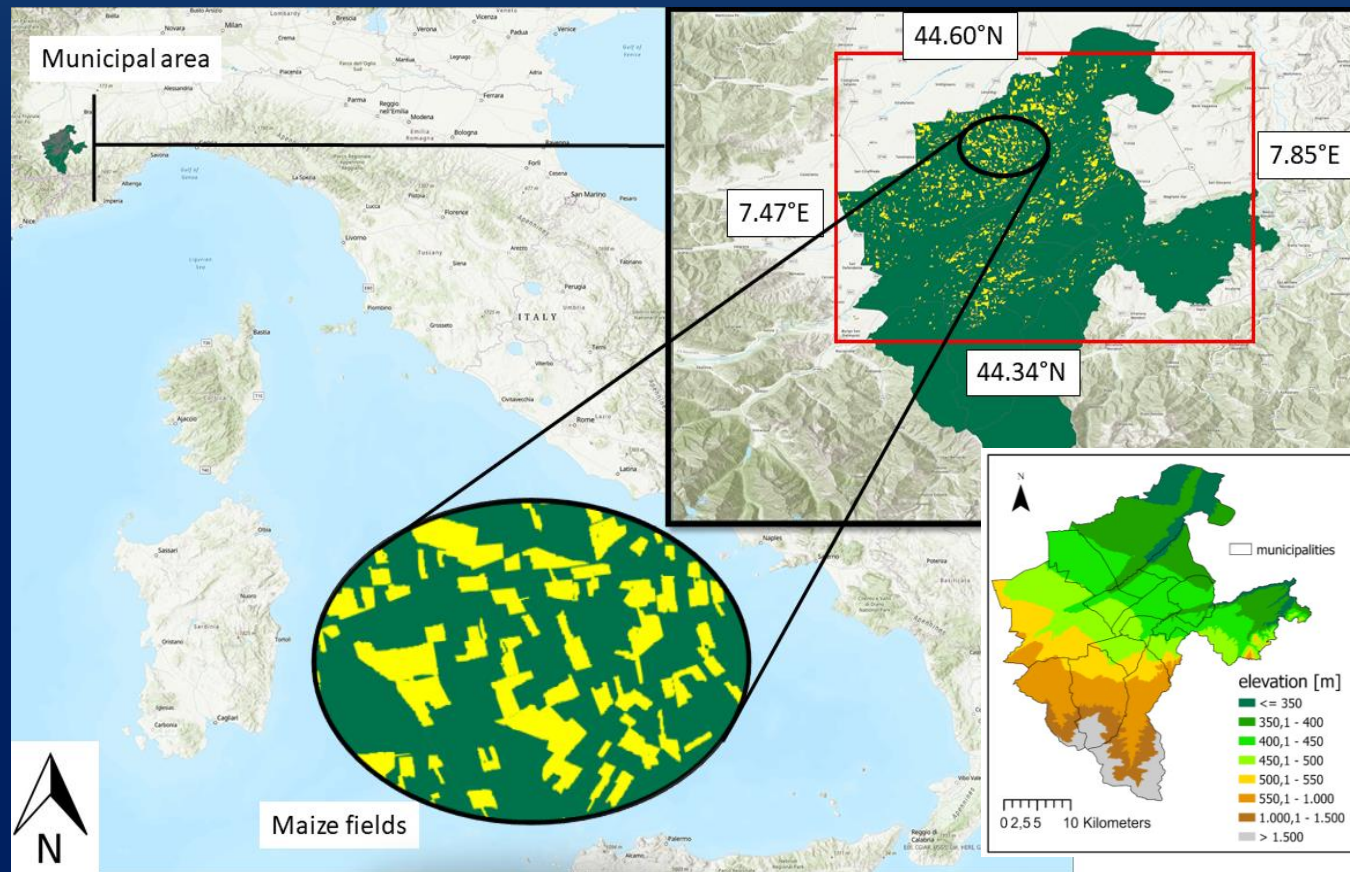
Type of data	Source	Resolution	Frequency
Optical (VIS, NIR)	Sentinel-2	10x10 m	6-days
SAR (C-band, VV-VH)	Sentinel-1	10x10 m	6-days
Soil Moisture (% of water in bare soil, 3-5 cm upper soil layer)	Theia French Land Data Service	10x10 m	6-days

May, 15th 2019

NDVI [-]
- <= 0.3
- 0.31 - 0.4
- 0.41 - 0.5
- 0.51 - 0.6
- > 0.6

- Optical data → *NDVI* (Normalized Difference Vegetation Index)

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

Indicator of leaves status and plant vigour

June, 11th 2019

VH/VV [dB]
- < -12
- (-12) - (-10)
- (-10) - (-8)
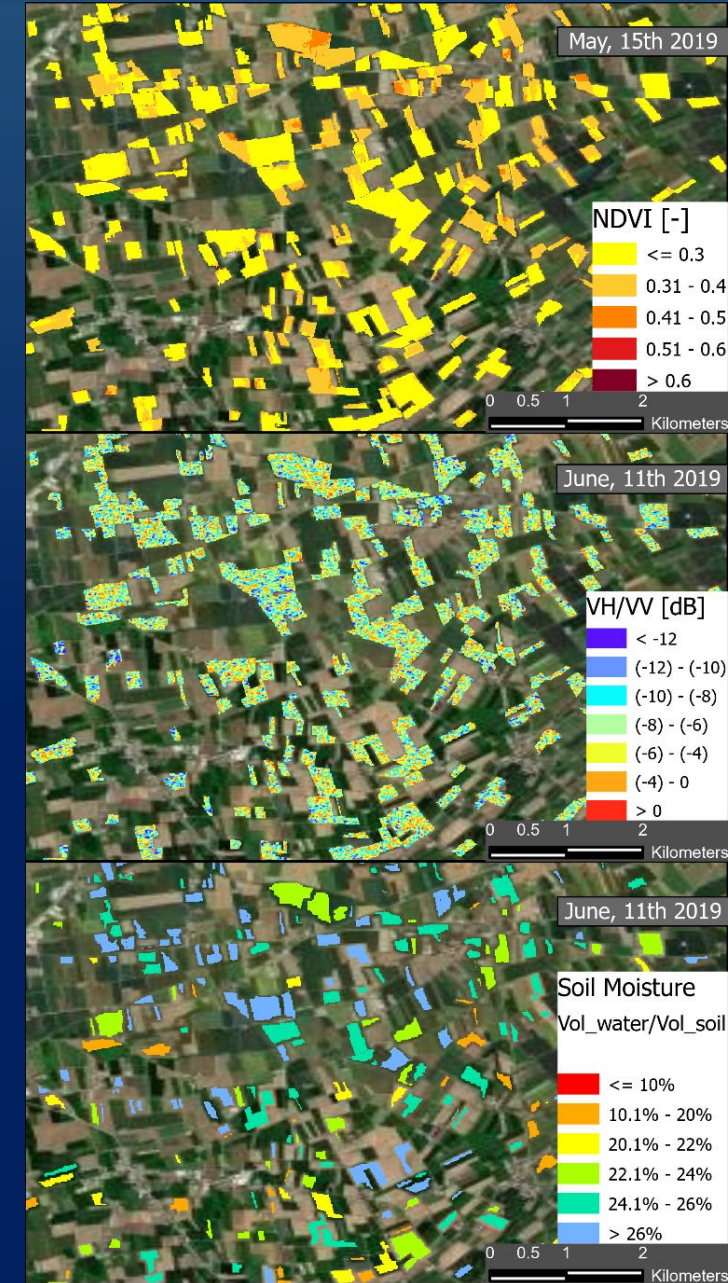- (-8) - (-6)
- (-6) - (-4)
- (-4) - 0
- > 0

- SAR data → *IPR* (Polarimetric Ratio Index)

$$IPR = \frac{\left(\frac{VH}{VV}\right) - \left(\frac{VH}{VV}\right)_{min}}{\left(\frac{VH}{VV}\right)_{max} - \left(\frac{VH}{VV}\right)_{min}}$$

The VH/VV ratio is sensitive to <u>ground geometric changes</u> and suitable for crop growth monitoring.
IPR → normalized VH/VV, considering MAX and MIN values over each field (May-Oct)

June, 11th 2019

Soil Moisture
Vol_water/Vol_soil
- <= 10%
- 10.1% - 20%
- 20.1% - 22%
- 22.1% - 24%
- 24.1% - 26%
- > 26%

- Soil Moisture → used to retrieve the length of pre-emerging maize periods

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Retrieving of sowing dates from daily temperature information:

$$GDU_i = \frac{T_{max,i} + T_{min,i}}{2} - T_{base}$$

- GDU: daily Ground Degree Units (°C), *i*-field
- T_{max}, T_{min}: daily max and min temperatures (°C)
- T_{base}: crop-specific threshold temperature (maize: 10°C)

Check for rainfed practices on fields out from irrigation districts.

Analysis of seasonal NDVI and VH/VV.

| Emerging day | **ΣGDU=66.7 °C** | +16.7 °C for low soil moisture | Sowing day |

PRE-EMERGING PERIOD

2. NDVI and VH/VV series

4. Length of pre-emerging periods

MAIZE SOWING DATES AT THE FIELD SCALE

1. Crop Classification

3. Identification of maize emerging

Identification of maize fields

CADASTRAL DATA + NDVI series

1'154 maize fields >1 ha

Year 2019
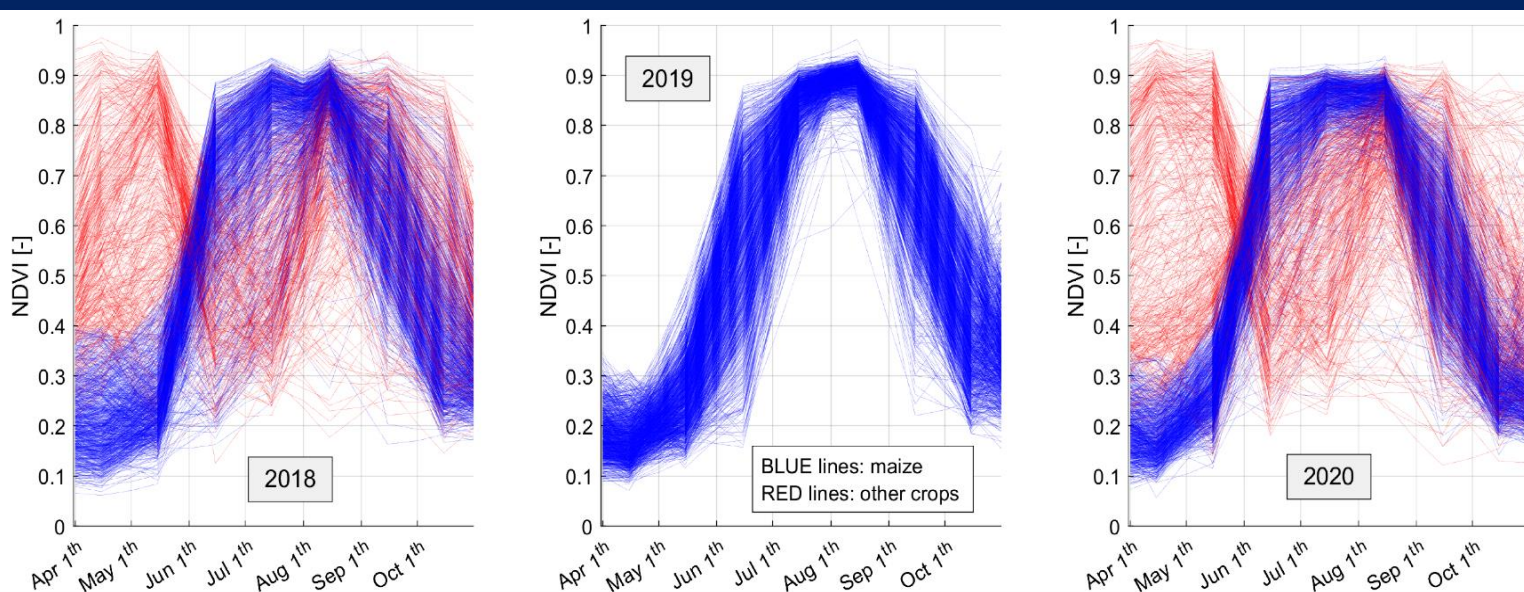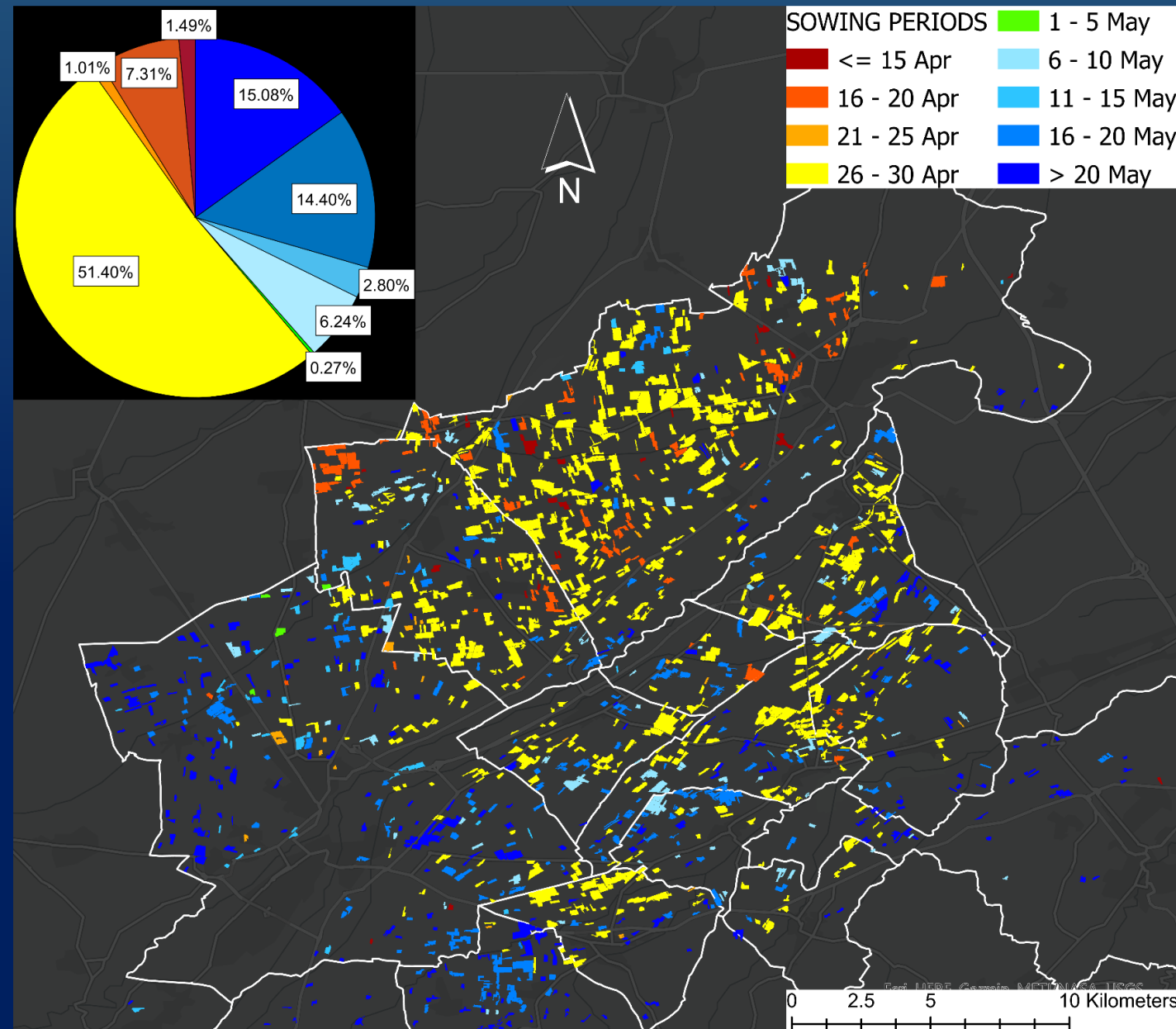

maize fields

Filtering the *IPR* index to remove the noise induced by soil moisture variability of bare soil (NDVI < 0.3).

Identification of the ground geometric changes induced by plant emerging → *IPR* increment

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- NDVI series highlight the crop rotation on the selected fields: *__year-specific sowing dates__* (pilot year → 2019)

- The combined NDVI and VH/VV analysis does not highlight significant rainfed practices.

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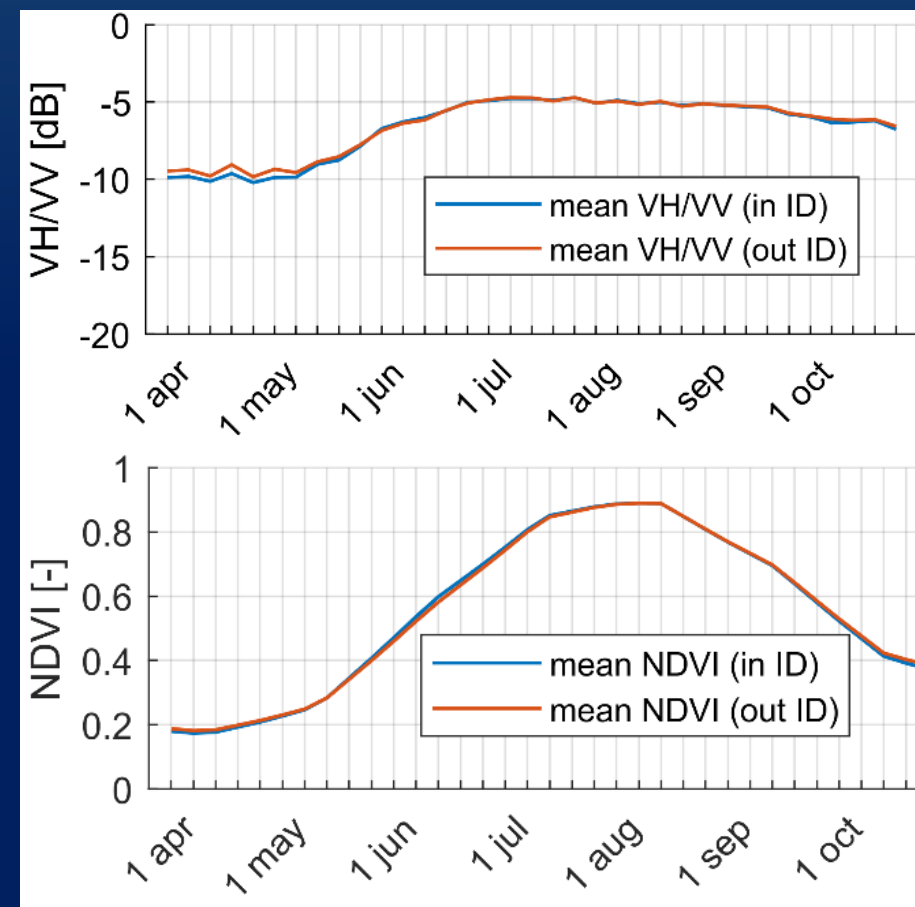
Results: SOWING DATES

Emerging periods (2019)
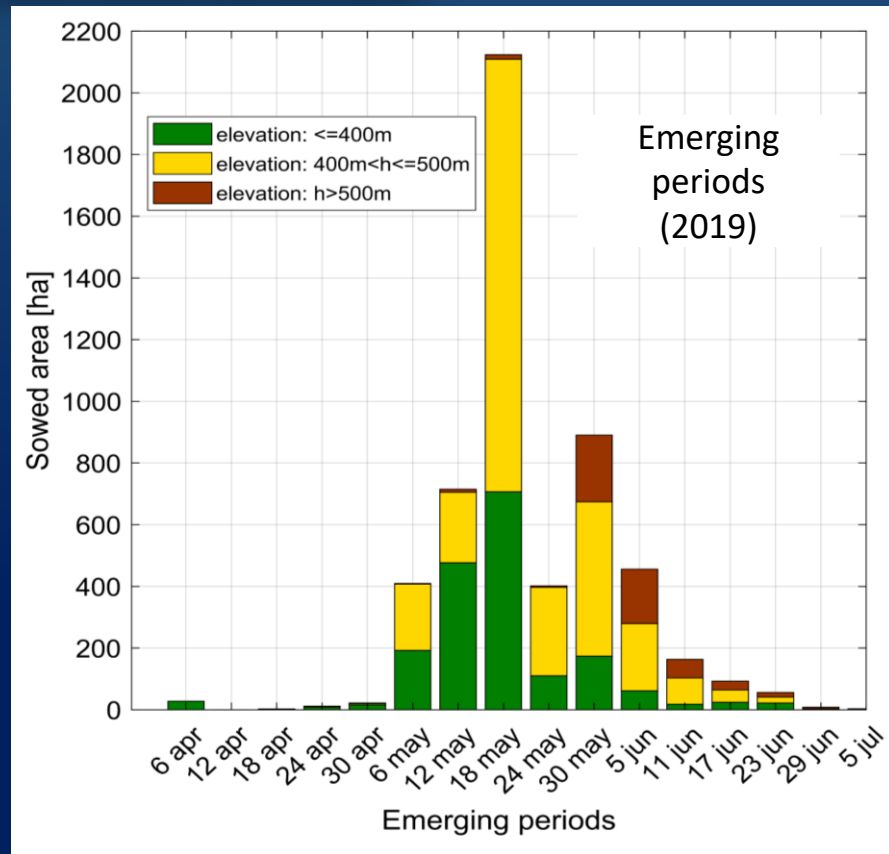
- Later sowing at higher elevations.
- Two main sowing periods → 26-30 Apr, 11-30 May
- Sowing results confirmed by local farmers, interviewed between October and November 2021.

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Thank you for the attention

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