

NDRE Chlorophyll Response Analysis Report — Corn/Maize Field

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Executive Summary

Across the surveyed corn/maize field, single-date NDRE values average -0.039 (median -0.056, standard deviation 0.115) over a valid raster area of 99,147,384 pixels (60.8% of the raster extent). The dominant NDRE range is -0.1 to 0.1, holding about 62% of valid pixels; roughly 28% of pixels fall below -0.1 and about 10% exceed 0.1. Red Edge response is spatially structured (Moran's $I \approx 0.67$) but shows more local variability than the field's NDVI signal, with about 17% of the area showing sharp local transitions. A clear west-to-east gradient is present — the western and central thirds of the field average negative NDRE while the eastern third turns positive — while north-south position shows little difference. These are measured observations from the NDRE raster only; NDRE is interpreted here strictly as a spectral indicator, and no cause is diagnosed.

Data & Methodology

This assessment uses only the `maize_NDRE` raster layer from the project's QGIS workspace (`maize.qgz`): a single-band Float32 NDRE (Normalized Difference Red Edge) raster, $9,872 \times 16,511$ pixels at a native ground resolution of approximately 2.74 cm/pixel, projected in WGS 84 / UTM Zone 32N (EPSG:32632) — consistent with a high-resolution drone (UAS) orthomosaic. Of 162,996,592 total pixels, 99,147,384 (60.8%) carry valid NDRE values; the remainder are flagged no-data, corresponding to the rectangular bounding extent around an irregular flight or field boundary rather than vegetation absence.

All statistics, value-range descriptions, and spatial observations in this report are computed directly from this single raster's pixel values. No vector layers, polygons, zonal overlays, other project layers (RGB composite, NDVI, OSAVI, or individual spectral bands), or external spatial datasets were used or created, and no new GIS output layers were generated. Local spatial variability was assessed using a 5×5-pixel moving-window standard deviation computed on an 8× spatially downsampled version of the raster ($1,234 \times 2,064$ cells) for computational tractability; large-scale spatial clustering was estimated with an approximate global Moran's I on the same downsampled grid. The low/intermediate/high NDRE bands used later in this report (below -0.1, -0.1 to 0.1, 0.1 and above) are fixed descriptive cut points chosen to match a natural break in the measured histogram — they are not derived classes, clusters, or spatial products.

NDRE Statistical Summary

All values below are measured directly from the 99,147,384 valid NDRE pixels (theoretical NDRE range -1 to 1).

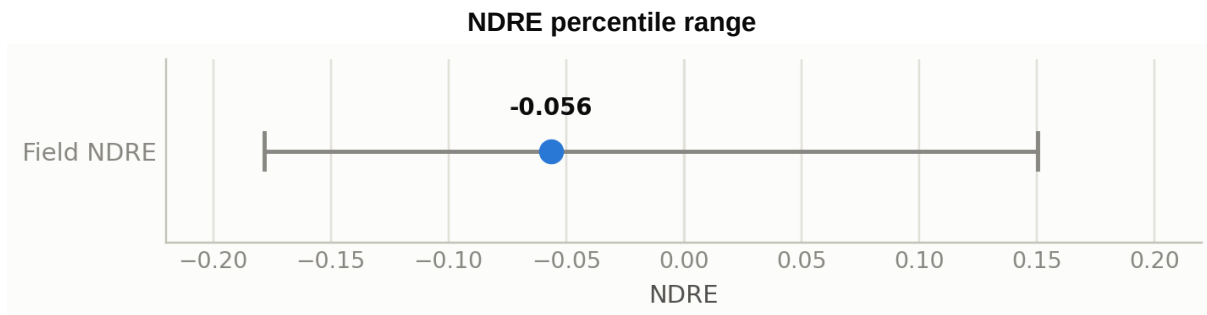
Statistic	Value
Minimum	-1.000
Maximum	1.000

Mean	-0.039
Median	-0.056
Standard deviation	0.115
Skewness	0.61
Excess kurtosis	16.56

Quartiles and percentile distribution

Percentile	NDRE
5th	-0.178
10th	-0.153
25th (Q1)	-0.107
50th (Q2 / median)	-0.056
75th (Q3)	0.018
90th	0.100
95th	0.150

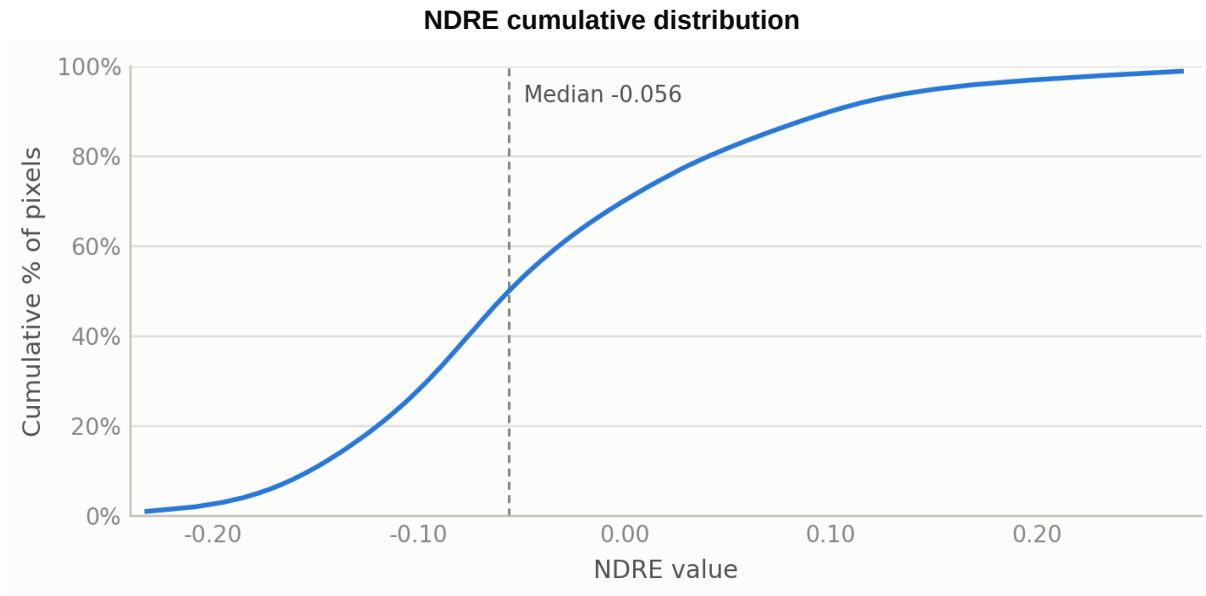
The interquartile range (Q1 to Q3) spans -0.107 to 0.018, about 0.125 NDRE units, and the 5th-95th percentile span (-0.178 to 0.150) covers roughly 0.33 units — a comparatively narrow band relative to NDRE's theoretical -1 to 1 range. Because the mean sits close to zero, the ratio of standard deviation to mean (coefficient of variation) is not a meaningful summary here and is omitted; the standard deviation alone (0.115) is a more useful measure of spread. Excess kurtosis (16.56) is very high, indicating a distribution far more sharply peaked and heavier-tailed than a normal distribution — consistent with a tight core of values plus the isolated extremes described in the next section.



Dot = median; whisker = 5th–95th percentile

maize_NDRE raster · field-wide percentile range

NDRE Distribution & Relative Proportions



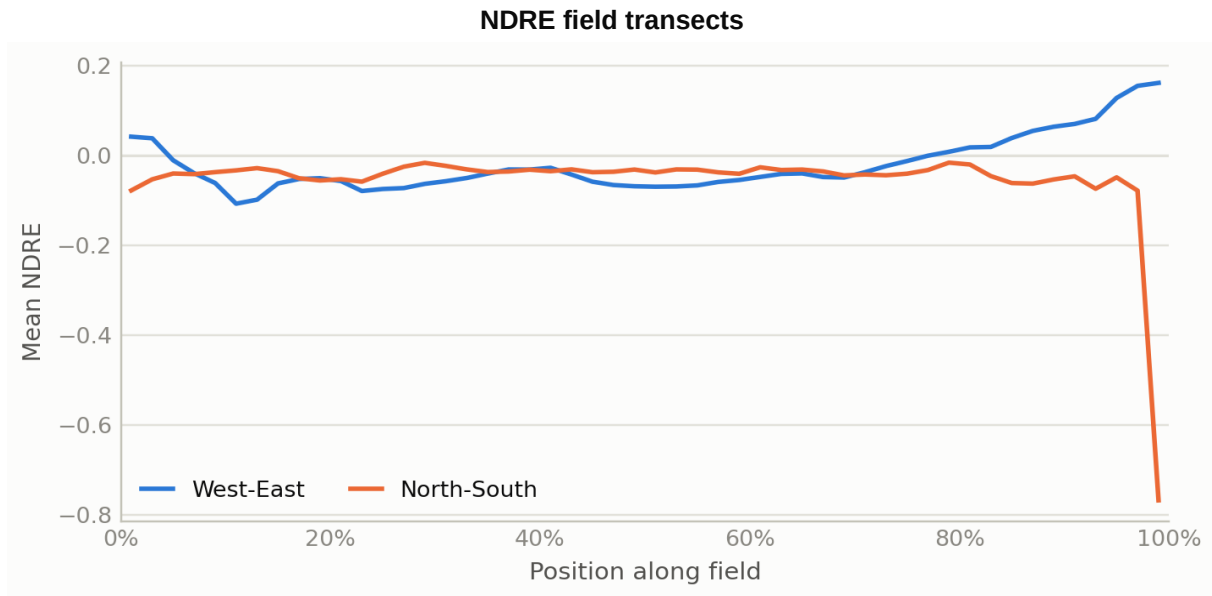
Cumulative share of valid pixels at or below each NDRE value (1st–99th pct)

maize_NDRE raster · 99,147,384 valid pixels · 1st–99th percentile

The distribution is unimodal and sharply peaked just below zero: the two bins spanning NDRE -0.1 to 0.1 alone hold about 61.4 million pixels (62% of all valid pixels), with the -0.1 to 0.0 bin the largest at 41.8 million pixels (42%). Using descriptive cut points chosen to match this natural break (low below -0.1, intermediate -0.1 to 0.1, high 0.1 and above), about 28% of valid pixels are low, 62% are intermediate, and about 10% are high — so the dominant, most common Red Edge response across the field is the intermediate band immediately around zero, not a strongly positive or strongly negative response.

Two isolated spikes sit well outside this main cluster: 160,683 pixels (0.16% of valid pixels) at NDRE -1.0 to -0.9, and 138,033 pixels (0.14%) at 0.9 to 1.0. As with a similar pattern seen in this field's NDVI raster, both are measured values present in the data; because they are numerically isolated from the smooth main distribution and sit at the extreme theoretical limits of NDRE, they most plausibly correspond to residual edge, shadow, or saturation artifacts rather than typical Red Edge canopy response — this is an interpretation, not a measured classification, and is flagged for visual or field confirmation rather than treated as vegetation signal.

Spatial Pattern Analysis



Mean NDRE by relative position, West-East vs North-South (50 bins each)

maize_NDRE raster · 50-bin transects, each direction

The chart above averages NDRE over a 24×40 equal-area grid (each cell $\approx 411 \times 413$ pixels, roughly 11×11 m on the ground) so field-scale pattern is visible without altering the underlying pixel values. Spatial autocorrelation is strong (Moran's $I \approx 0.67$ on an 8× downsampled grid), meaning neighboring areas tend to have similar NDRE values rather than varying at random. At the same time, local variability is more pronounced here than in this field's NDVI signal: about 17% of the field area shows a local 5×5-cell-window standard deviation above 0.08, versus roughly 3% for the equivalent NDVI check, indicating the Red Edge response is somewhat more locally patchy even where broad spatial structure is present.

At field scale, mean NDRE by thirds of the image shows little north-south difference (north third -0.039, middle third -0.034, south third -0.044 — essentially flat) but a clear west-to-east gradient (west third -0.061, central third -0.052, east third +0.008 — the west and center are consistently below zero while the east crosses into positive territory). This west-to-east pattern echoes a similar gradient seen in this field's NDVI raster. The chart above shows finer structure within these averages, including a relatively reduced Red Edge response (more negative NDRE) concentrated through the west-central portion of the field, and a relatively elevated response (less negative to positive NDRE) concentrated along the eastern margin. A small number of isolated cells with extreme low values (below -0.3) sit near the field's outer margins rather than its interior, consistent with the edge or no-data artifacts noted in the distribution section rather than an interior anomaly — this attribution is an interpretation, not a direct measurement.

NDRE as a Chlorophyll-Sensitive Indicator

NDRE (Normalized Difference Red Edge) uses the red edge spectral band, which is sensitive to chlorophyll content and canopy structure in ways the red band used by NDVI is not: red edge reflectance responds to changes in chlorophyll concentration across a wider range of canopy density, including denser or more mature canopies where NDVI can saturate. In principle, this makes NDRE a useful complementary spectral indicator of relative chlorophyll-related vegetation condition in corn, particularly once the canopy has closed enough that NDVI stops discriminating differences.

Within that role, the measured NDRE values in this raster — mostly clustered in a narrow band around -0.1 to 0.1 — describe relative differences in Red Edge response across the field, and by extension relative differences in the red-edge-sensitive component of canopy reflectance, without directly measuring chlorophyll content itself. NDRE is a spectral index, not a lab or in-field chlorophyll measurement (such as a SPAD reading), and its relationship to actual chlorophyll concentration depends on factors this report does not evaluate, including growth stage, canopy geometry, illumination and view angle, sensor calibration, and atmospheric conditions at capture. Areas of relatively lower or higher NDRE in this raster can be described as spectrally different in their Red Edge response; whether that spectral difference corresponds to a real, meaningful difference in chlorophyll status, and if so why, cannot be established from this raster alone.

Consistency vs Heterogeneity Assessment

Based on the statistics above, the field's NDRE response is best described as spatially structured but not uniform. Two lines of evidence point toward structure rather than randomness: strong spatial autocorrelation (Moran's $I \approx 0.67$) shows that NDRE values are organized into broad, gradually varying zones rather than scattered at random, and the dominant intermediate band (-0.1 to 0.1) accounts for the clear majority (62%) of the field, indicating most of the field shares a broadly similar Red Edge response.

At the same time, the field is measurably heterogeneous rather than flat: about 28% of the field falls below -0.1 and about 10% exceeds 0.1, a real spread rather than noise, and this spread has a spatial pattern — the pronounced west-to-east gradient, plus about 17% of the field area showing sharp local transitions (a higher share of local heterogeneity than this field's NDVI signal showed). Taken together, the field is neither uniformly consistent nor randomly heterogeneous: it behaves as a spatially coherent surface with a real, structured gradient and a meaningful minority of more locally variable area, concentrated in identifiable parts of the field rather than spread evenly throughout.

Uncertainty & Limitations

This is a single-date, single-raster NDRE assessment: no repeat imagery, ground reference (such as SPAD chlorophyll meter readings), or other spectral/index layers (RGB, NDVI, OSAVI, individual bands) were used to corroborate the findings, so temporal trend and independent confirmation both fall outside this report's scope. The acquisition, sensor, radiometric calibration, and processing workflow behind the `maize_NDRE` raster are not documented in the QGIS project metadata available to this analysis; sensor- or processing-related artifacts (for example vignetting, mosaic seams, or calibration drift) cannot be ruled out and could contribute to some of the extreme values noted, particularly the NDRE -1.0 to -0.9 and 0.9 to 1.0 spikes.

The 60.8% valid-pixel coverage means close to two-fifths of the raster's bounding rectangle carries no data; this reflects the flight or processing extent rather than field condition, but it does mean the 24×40 spatial grid and the downsampled local-variability statistics are less densely sampled toward the raster's edges. Spatial variability statistics (local standard deviation, Moran's I) were computed on an 8× downsampled grid for computational tractability and are approximate rather than full-resolution measures. The low/intermediate/high NDRE bands (-0.1, 0.1) used earlier are fixed descriptive cut points chosen to match a break in this raster's own histogram; they are not calibrated to any validated chlorophyll or crop-condition threshold. Finally, as discussed above, NDRE is interpreted here strictly as a spectral indicator: this report does not establish, and does not attempt to establish, a specific physiological or agronomic cause for the patterns described.

Summary

This field's NDRE signature is centered close to zero and slightly negative (mean -0.039, median -0.056), with the great majority of measured Red Edge response (about 62% of valid pixels) falling within a narrow -0.1 to 0.1 band; roughly 28% of the field reads below that band and about 10% above it. The distribution is unimodal, sharply peaked, and right-skewed, with two small, spatially marginal groups of extreme values (near NDRE -1.0 and near +1.0, together under 0.3% of valid pixels) that most plausibly reflect edge, shadow, or saturation artifacts rather than canopy signal.

Spatially, the field is coherent rather than random (Moran's $I \approx 0.67$) but not uniform: a clear west-to-east gradient runs through the field, with the western and central thirds averaging negative NDRE and the eastern third crossing into positive values, while north-south position makes little difference. Roughly 17% of the field area also shows sharp local transitions, somewhat more locally patchy than this field's NDVI signal. For crop monitoring, the practical significance of these findings is that Red Edge response is not homogeneous across this field on this date: the west-central portion of the field reads consistently lower than the eastern portion, and this spatial contrast, along with the field's generally low overall NDRE level, is worth a field check. Because NDRE is treated here strictly as a spectral indicator, this report identifies where and how much Red Edge response varies, without asserting or ruling out any specific physiological cause.