Monitoring Maize Harvest in Northern Iowa Using Sentinel Data and Google Earth Engine

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Introduction

Agriculture has been studied extensively in remote sensing, however one aspect of agricultural research that is lacking is determining the time of when harvest is occurring. The goal of this project was to uncover measurable changes in remotely sensed optical and radar data caused by harvest in maize fields in Iowa. In our examination of the literature, we found only two papers on when harvests are occurring, for sugarcane and wheat, but none on maize harvest.

Radar has become increasingly common in the remote sensing of agriculture due to radar's ability to penetrate clouds, which plagues optical data. Another driving force of the popularity of Radar has been the Senitnel-1 SAR sensors, which is freely available to the public, at a high resolution. Based on the literature there is likely a decrease in VV and VH bands caused by harvesting. The usefulness of optical data is in question because the properties of maize start changing due to senescence before the harvest occurs. However, some authors suggest using NDVI and have had some success.

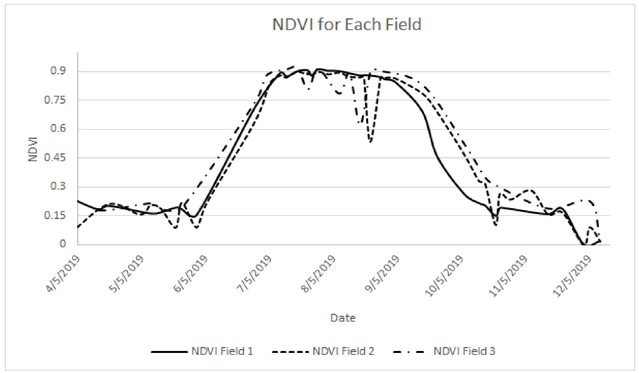
Data/Methods

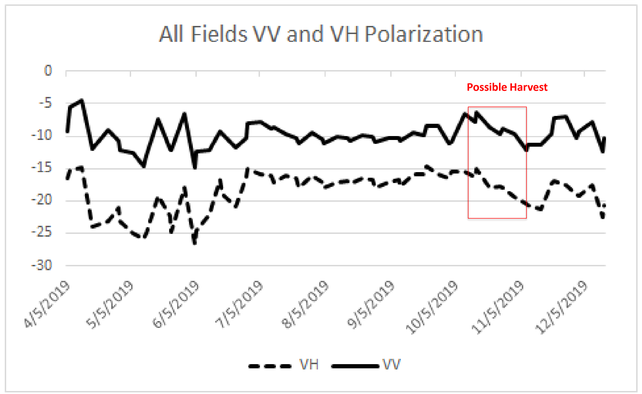
Dataset	Date	Spatial resolution	Temporal Resolution	Source
Sentinel 1 VV and VH	April-December 2019	10m	3-day revisit or less	ESA
Sentinel 2 red and nir	April-December 2019	10m	5-day revisit	ESA

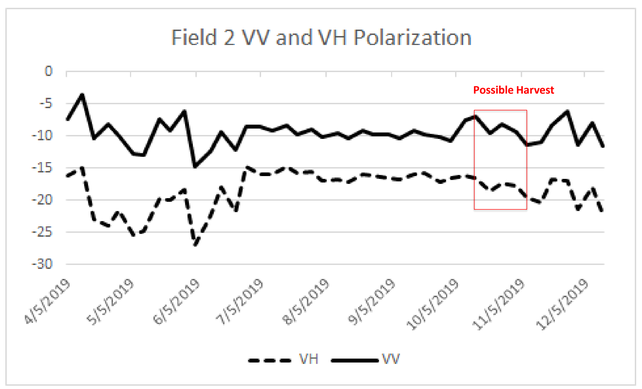
The Sentiel-1 data was imported into Google Earth Engine (GEE). It was filtered to reduce speckle. The VV and VH bands were selected from the image collection. Sentinel-2 data was imported into GEE. That data was filtered to eliminate dates on which the cloud cover was too great. The NDVI was then calculated. Fields planted with maize in 2019 were identified using the USDA NASS's cropscape web map. Time series charts were created in Excel based on the data from GEE.

Research Questions

What is the reflective behavior of agricultural corn fields?
What is the best data source we can use to analyze agricultural crops?
What characteristics of corn can be detected to determine pre- and post-harvest?
What are the measurable changes in Sentinel-1, Sentinel-2, and Optical Imagery of corn fields from harvest?







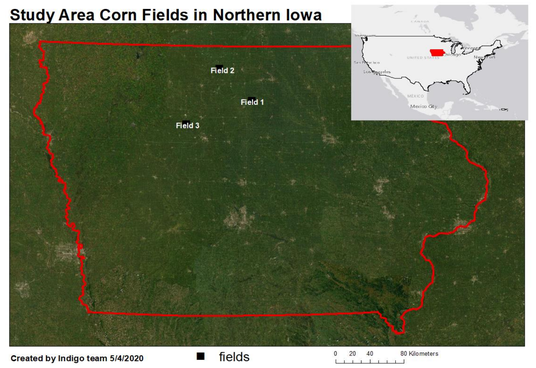
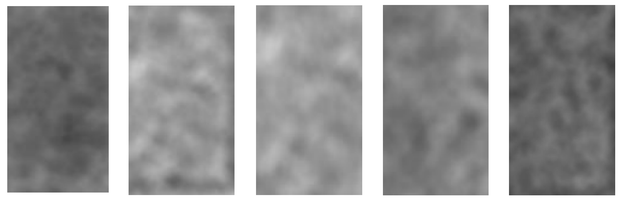
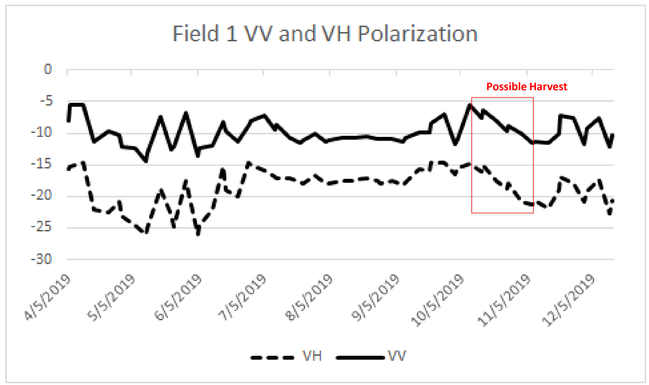
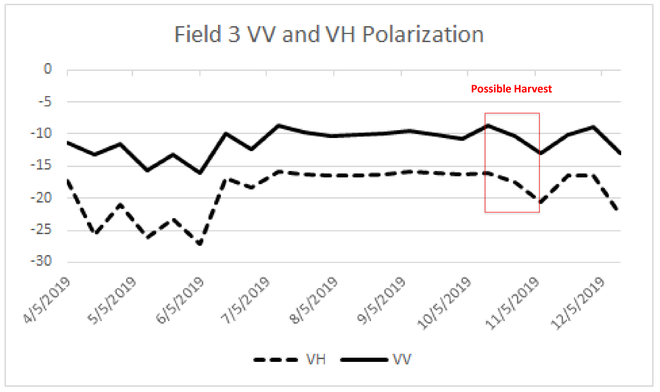


Image Collection of Field 1 VV Values During October







Summary and Recommendations

The chart of NDVI over the growing season shows a high values around the end of August, then a steep decline from senescence that blends into harvest. There is a leveling off from the decline around mid-to-late October. This indicates that the usefulness of NDVI for this purpose is dubious. Some data points are being affected by clouds, although the most affected dates have been removed.

The charts for the VV and VH polarizations from the radar data show great variability before early July, then leveling off for the rest of the growing season. VV then spikes upwards at the beginning of October before decreasing back to a point slightly lower than the middle of the growing season. VH stays mostly stable until the middle of October when it starts a decline to well below the middle of the growing season numbers.

There are declines in VV and VH across multiple imagery dates spanning multiple weeks from approximately October 14th to November 5th. This indicates that the signal from the data contains multiple events, which could include harvest, stover harvest and strip tilling.

Overall, radar sensors do have potential for the detection of maize harvest, but further research is required. We recommend using radar data including VV and VH polarizations. Other research has shown that using Sentinel 1 SLC VV and VH backscatter coefficients along with the measurement of coherence between images can be useful. We recommend finding ground truth data on harvesting times as well as other possible activities such as stover harvest or strip tilling.

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