FARM & RURAL CREDIT MISSION (FRCM) - SCORE

1. Introduction

Agricultural credit lending is a difficult problem from an information asymmetry perspective. Farmers know more about their creditworthiness and the state of their farms than lenders do. Lenders can't undertake all the due diligence necessary to holistically determine who is a safe borrower other than assessing the value of land, which is crude measure and does not take into account farm's productivity as well as agricultural practices. A farmer's credit worthiness is dependent upon their farm health, which is a combination of infrastructure, farming practices, input quality, weather events, productivity and prevalent prices. A farm's health can be easily monitored by remote sensing in a cost-effective manner. FRCM is a measure to monitor a farm's health over a period of time.

FRCM Score is an intuitive and intelligent measure to assess the productivity of an agriculture field based on historical and current remote sensing data for that particular field. FRCM score is a weighted mean score of five different components: number of crop seasons per year, crop health, crop nutrition, canopy moisture and soil moisture estimated using vegetation indices. This score can be used to assess farm productivity; evaluate farming behaviors and practices; forecast output, determination of productivity enhancements; and credit risk evaluation. FRCM score, when combined with right agronomist expertise, also explains a farm's condition and crop management practices applied to the farm

2. Executive Summary

Traditionally, banks have had a very broad brush approach of assessing farmer credit risks. Most of the credit which is available to the agricultural sector is through the priority sector lending mandate for the banks set out by the government. While this process is mainly driven by compulsion rather than a sense of business opportunity, the rigor of checks and follow ups to secure the credit risk is often lack sided which is amply visible in YOY renewal of credit for existing borrowers with decent repayment history. Also, there exists an acute realization amongst farmers to distinguish the capability of loan repayment from their current borrower credit score (CIBIL, others, etc. which takes into account historical loan repayments) which might get affected due to the vagaries of nature impacting the marketing of produce resulting in delayed repayments.

There is a need for lenders to improve the flow of credit to the agricultural sector using data driven and inference oriented credit assessment capabilities. This approach will offer an ecosystem for agricultural financing and policy making besides helping insurers, regulators, policy institutions for growth and financial inclusion in the agricultural sector. Financial inclusion must be accompanied by a mechanism that reduces the risk associated with lending for both, the borrower and the creditor reducing the probability of loan failures. This requires empowering the farmers to utilize the credit obtained to adopt appropriate agricultural practices, use high-quality inputs, leverage the latest technology available to tackle weather and climate uncertainties and improve productivity. There is a need to envision a system that can provide the necessary structure for this cycle.

We propose an equivalent FRCM Score which is derived from the data available on the farmers field using satellite imagery and meteorological sources. The approach allows to identify the borrower's ability to repay the loan by inferring agricultural practices at the field level vis-a-vis cultivation cycles, vegetation health, nutrition management and likely yield. The score aims to give actionable intelligence to the creditors who generally have little to no information at the field level so that they can manage the risks and manpower more efficiently. The computation of FRCM Score is based on processing satellite images at scale to draw a time series analysis over a large area of interest. This output is based on a methodology that integrates remote sensing satellite data, weather and hazard databases, historical yields and farmer land records, and involves complex artificial intelligence and machine learning-enabled data modeling. This methodology has been tested in our pilot studies. Since the source of the data and computation method is the same, the FRCM Score allows comparison of scores derived for multiple fields (Refer Validation Section; Figure 1: Comparing FRCM Scores with Rabi 2021 productivity, Jaisalmer (Rajasthan) and Figure 2: Scatter Plot (Yield vs FRCM Score)). The score can also be used as a monitoring tool to know the borrower's performance over the cultivation seasons. Monitoring the various components of FRCM score can serve as early warning triggers on expected losses at the field level which can again be used to validate insurance claims and plan for operations to mitigate and intervene in a timely manner. The heatmap of the scores can be used by the lenders to prioritize lending and venture into new territories for operation.

Existing Solutions in the market:

1. RMSI
2. SATYUKT
   https://satyukt.com/sat2credit-insight-into-farm-income-and-risk-by-satellite-remote-sensing-for-bfsi/
3. DVARA
   https://www.dvaraeregistry.com/insights/khetscore-a-comprehensive-farm-index/
4. SATSURE
   https://newsroom.transunioncibil.com/transunion-cibil-and-satsure-launch-cibil-credit-and-farm-report-ccfr-to-expand-farmers-access-to-credit/
5. Fram Infinity

   https://farminfinity.com/Sample_Credit_Report.png

3. Building FRCM Score - Remote Sensing Concepts

Some of the concept indices used for high level analysis by FRCM Score are NDVI, NDRE, EVI, VARI, SOC, NDWI, etc according to the different parametric stages in cultivation cycle

RS Index	**Data Source**	**Description**	**Monitoring parameter**
NDVI (Normalized Difference Vegetation Index)	Sentinel 2	NDVI is used as a measure to identify the state of plant health based on the light reflected by the plant at certain frequencies. Though we cannot perceive it with our eyes, everything around us (including plants) reflects wavelengths of light in the visible and non-visible spectrum. Taking into account how much of a certain wavelength is reflected, we can access the current status of plants.	Crop health at early growth stage
EVI (Enhanced Vegetation Index)	Sentinel 2	EVI is further an optimized index designed to enhance the vegetation signal with improved sensitivity in high biomass regions and improved vegetation monitoring through a decoupling of the canopy background signal and a reduction in atmosphere influences.	Crop health at early and mid growth stage
NDRE (Normalized Difference Red Edge)	Sentinel 2	NDRE is a spectral index that helps in gathering the data at the later stages of a crop when chlorophyll content is relatively higher in the crop.	Crop health of crop at later growth stage
NDWI (Normalized Difference Water Index)	Sentinel 2	The high NDWI values correspond to high plant water content and coating of high plant fraction, whereas the low NDWI values correspond to low vegetation content and cover with low vegetation. NDWI rate will decrease during periods of water stress. Hence, through NDWI, the early detection of water stress can prevent many of the negative impacts on crops.	Irrigation
NDMI (Normalized Difference Moisture Index)	Sentinel 2	NDMI is used to know the moisture index / water stress in vegetation which helps in monitoring the drought condition of the areas. The kind of vegetation must be taken into account to further know the amount of water to use at particular growth stages of crops.	water stress condition
ET		Evapotranspiration measures the rate at which evaporation and transpiration	Irrigation

		occurs at multiple locations. Through evapotranspiration one can easily schedule the irrigation based on the indicators - (contd.) received by the data. Nevertheless, it can be ignored if NDWI and NDMI data result in a good condition.	
DEM (Digital Elevation Model)		DEM is used to know the waterlogging prone areas in the field. During heavy rainfall or excess irrigation, the areas where the water logged or flood occurs can be identified through DEM. Hence, by knowing such areas the passage for the outsourcing of the water can be ensured by installing more motors in the area.	Water logging, Flooding
SOC (Soil Organic Carbon)	SoilGrid rest API	SOC is a measurable component of the soil organic matter that indicates the better health and yield of any land once the cultivation process ends. Remote Sensing technology plays a vital role In enabling farmers to ensure high SOC content by taking the right measures at the right time and the right place. PFRM creates a SOC image with a color map of the percentage of organic matter present in the selected field. The land area appears green in the color map if SOC content is more than 5% and red if the SOC content is less than 1%. Once the locations with lesser SOC levels are identified by PFRM, farmers can get the soil testing done on specific regions, and the required actions can be taken.	Soil health
RVI (Radar Vegetation Index)	Sentinel 1	RVI is measured by the backscattering which does not affect the data. The RVI data was designed to be the time series data which can be a great alternative to the NDVI. However, RVI can be obtained at extreme weather conditions when the satellite data could not be obtained due to cloudy or any other weather conditions.	Crop health during Cloudy weather
RGB images of the field	Sentinel 2	TCI (True Color Image): It is basically raw image of the field captured by satellite of a particular farm. This is not an index image, but a RGB representation of	Ground Visit

		how the field looked like in human perceivable colors upon its last visit. It -(contd.) helps in identifying functional field units correctly.	

Using the satellite data summary provided by FRCM Score in the form of comprehensible information, farmers can:

- Reduce chemical/Fertilizer consumption by applying it only at the locations where crop health is in bad condition.
- Reduce Labor costs by directing the labor only to the areas where crop health is low.
- Reduce irrigation water wastage by knowing the water stress.
- Increase the overall yield.
- Maintain nutrient composition by knowing the soil carbon content.

3.1 Data Description

3.1.1 Remote Sensing Data

The Sentinel-2 individual bands e.g., B4, B5, B7, B8, B8a, B11 and B12 for an area of interest are acquired from AWS public repository in this data collection B1, B9 and B10 bands were not collected because they were dedicated to atmospheric corrections and cloud screening.

Sentinel-2 images irradiance value was converted to reflectance value by using conversion factor. All bands are converted to 10 m resolution with a cubic convolution resampling method.

3.1.1.1 Spatial Resolution

The surface area measured on the ground and represented by an individual pixel, is termed as the spatial resolution. Below table shows three possible spatial resolutions.

3.1.1.2 Temporal Resolution

Temporal resolution is the amount of time, expressed in days, that elapsed before a satellite revisits a particular point on the Earth's surface. The satellite in the Sentinel-2 constellation will provide a revisit time of five days at the equator in cloud free conditions.

3.1.1.3 Radiometric Resolution

Band	Resolution	Central Wavelength	Description
B1	60 m	443 nm	Ultra-blue (Coastal and Aerosol)
B2	10 m	490 nm	Blue
B3	10 m	560 nm	Green
B4	10 m	665 nm	Red
B5	20 m	705 nm	Visible and Near Infrared (VNIR)
B6	20 m	740 nm	Visible and Near Infrared (VNIR)
B7	20 m	783 nm	Visible and Near Infrared (VNIR)

B8	10 m	842 nm	Visible and Near Infrared (VNIR)
B8a	20 m	865 nm	Visible and Near Infrared (VNIR)
B9	60 m	940 nm	Short Wave Infrared (SWIR)
B10	60 m	1375 nm	Short Wave Infrared (SWIR)
B11	20 m	1610 nm	Short Wave Infrared (SWIR)
B12	20 m	2190 nm	Short Wave Infrared (SWIR)

3.2 Feature Extraction

Some vegetation indices, such as Normalized Difference Vegetative Index (NDVI), Normalized Difference Moisture Index (NDMI), Red-Edge, and Normalized Multi-Band Drought Index (NMDI) have been identified to measure crop biophysical parameters to assess crop condition during crop cycle.

3.2.1 Normalized Difference Vegetation Index

NDVI is one of the most suitable to track crop development dynamics since it measures photosynthetically active biomass in plants. Since photosynthesis products comprise 95% of the crop's dry mass, it is necessary to monitor the photosynthetic activity of plants to prevent it from dropping in advance. Such an approach allows for identifying affected crop areas and responding in a timely manner so that the plants stay healthy. Calculation of the Normalized Difference Vegetation Index (NDVI), which is available on-the-fly, comes first. In addition, NDVI is often used around the world to monitor drought, forecast agricultural production, assist in forecasting fire zones, and desert offensive maps. NDVI is preferable for global vegetation monitoring since it helps to compensate for changes in lighting conditions, surface slope, exposure, and other external factors.

$$NDVI = \frac{(B8-B4)}{(B8+B4)}$$

According to this formula, the density of vegetation (NDVI) at a certain point of the image is equal to the difference in the intensities of reflected light in the red and infrared range divided by the sum of these intensities. Simply, NDVI is a measure of the state of plant health based on how the plant reflects light at certain frequencies (some waves are absorbed and others are reflected). Chlorophyll (a health indicator) strongly absorbs visible light, and the cellular structure of the leaves strongly reflects near-infrared light. When the plant becomes dehydrated, sick, afflicted with disease, etc. The spongy layer deteriorates, and the plant absorbs more of the near-infrared light, rather than reflecting it. Thus, observing how NIR changes compared to red light provides an accurate indication of the presence of chlorophyll, which correlates with plant health.

This index defines values from -1.0 to 1.0, representing greens, where negative values are formed from clouds, water and snow, and values close to zero are primarily formed from rocks and bare soil. Exceedingly small values (0.1 or less) of the NDVI function correspond to empty areas of rocks, sand, or snow. Moderate values (from 0.2 to 0.3) represent shrubs and meadows, while large values (from 0.6 to 0.8) indicate temperate and tropical forests.

Sr. No.	NDVI values range	INTERPRETATION
1	<0.1	Bare soil
2	0.1 – 0.2	Almost absent canopy cover
3	0.2 – 0.3	Very low canopy cover
4	0.3 – 0.4	Low canopy cover, low vigour or very low canopy cover, high vigour
5	0.4 – 0.5	Mid-low canopy cover, low vigour or low canopy cover, high vigour
6	0.5 – 0.6	Average canopy cover, low vigour or mid-low canopy cover, high vigour
7	0.6 – 0.7	Mid-high canopy cover, low vigour or average canopy cover, high vigour
8	0.7 – 0.8	High canopy cover, high vigour
9	0.8 – 0.9	Very high canopy cover, very high vigour
10	0.9 – 1.0	Total canopy cover, very high vigour

Key fact about NDVI is the most common vegetation index in remote sensing. It can be used throughout the whole crop production season except when vegetation cover is too scarce, so its spectral reflectance is too low. NDVI values are the most accurate in the middle of the season at the stage of active crop growth.

3.2.2 Normalized Difference Moisture Index

The Normalized Difference Moisture Index (NDMI) detects moisture levels in vegetation using a combination of near-infrared (NIR) and short-wave infrared (SWIR) spectral bands. It is a reliable indicator of water stress in crops. Severe drought conditions not only stress the crops but can destroy the entire yield. NDMI can detect water stress at an early stage before the problem has gone out of hand. Further, using NDMI to monitor irrigation, especially in areas where crops require more water than nature can supply, helps to significantly improve crop growth. All of this makes NDMI an excellent farm tool. Although colloquially NDMI is often compared with the NDWI index, the two should be effectively viewed as different indices. While NDMI and Gao's version of NDWI use the NIR-SWIR combination to detect moisture content in leaves, the McFeeters's NDWI uses the GREEN-NIR combination to highlight water bodies and monitor their turbidity. So, to avoid any confusion, NDMI uses a NIR-short-wave infrared band combination and should be treated as a separate index from the NDWI that measures water content of water bodies.

NDMI Formula: NDMI is calculated using the near-infrared (NIR) and the short-wave infrared (SWIR) reflectance:

$$NDMI = \frac{(NIR - SWIR)}{(NIR + SWIR)}$$

Sentinel-2:

$$NDMI = \frac{(B8 - B11)}{(B8 + B11)}$$

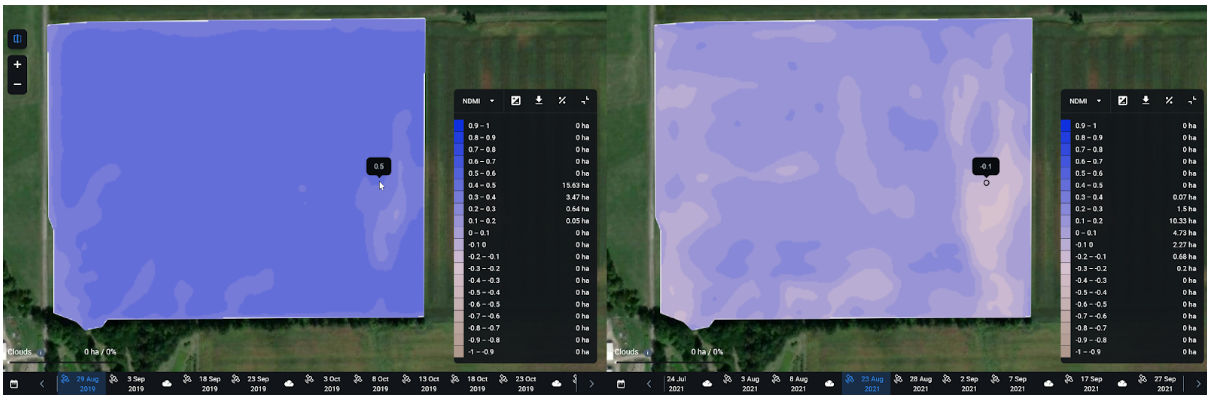
The NIR and SWIR bands were selected for the NDMI band equation to mitigate the effects of illumination and atmosphere. The short-wave infrared spectral channel (SWIR) is sensitive to the vegetation water content and the mesophyll structure of leaves. On the other hand, the near-infrared band (NIR) picks up the bright reflectance off the leaf internal structure and leaf dry matter content. When combined, the accuracy of data on the vegetation water content becomes much higher. Additionally, NDMI is a better deforestation indicator than NDVI thanks to a less abrupt decrease in values. NDMI can only have values between -1 and 1, which makes it extremely easy to interpret. Water stress would be signaled by the negative values approaching -1, while the +1 may indicate waterlogging. Therefore, every value in between will correspond to a slightly different agronomic situation.

Sr. No.	NDMI values range	Interpretation
1	-1 to –0.8	Bare soil
2	-0.8 to –0.6	Almost absent canopy cover
3	-0.6 to –0.4	Very low canopy cover
4	-0.4 to –0.2	Low canopy cover, dry or very low canopy cover, wet
5	-0.2 to 0	Mid-low canopy cover, high water stress or low canopy cover, low water stress
6	0 to 0.2	Average canopy cover, high water stress or mid-low canopy cover, low water stress
7	0.2 to 0.4	Mid-high canopy cover, high water stress or average canopy cover, low water stress
8	0.4 to 0.6	High canopy cover, no water stress
9	0.6 to 0.8	Very high canopy cover, no water stress
10	0.8 to 1.0	Total canopy cover, no water stress/waterlogging

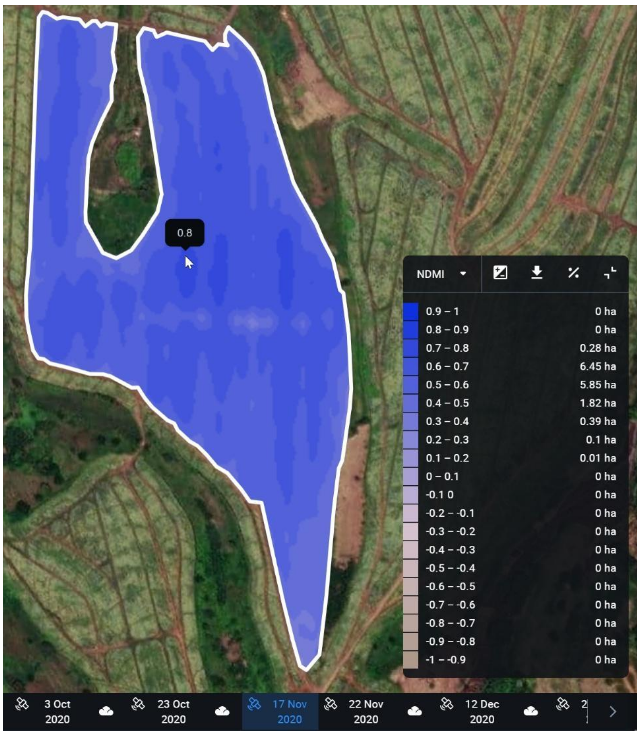
It is important to keep in mind that NDMI values vary throughout the growing season because the plants' reflectance is slightly different for every phenological stage. There also exists an interesting correlation between NDMI and NDVI. Water stress indicated by the NDMI values can be confirmed by a significantly lower than average NDVI. The Normalized Difference Moisture Index can be used to:

- Regularly monitor water content in crops,

- Determine field/farm zones with water stress,



On this screenshot, you can see two images of the same field taken 2 years apart, illustrating variations of NDMI values. Image on the left shows no signs of water stress, while image on the right reveals stressed crops after a prolonged period of unusually low precipitation in 2021. The field in below image seems to have some of its areas waterlogged because of recent heavy rains. Water has nowhere to escape in these areas, so it collects in pools. Waterlogging is a problem since it significantly reduces crop yield.



3.2.3 Red Edge Chlorophyll Vegetation Index (ReCl)

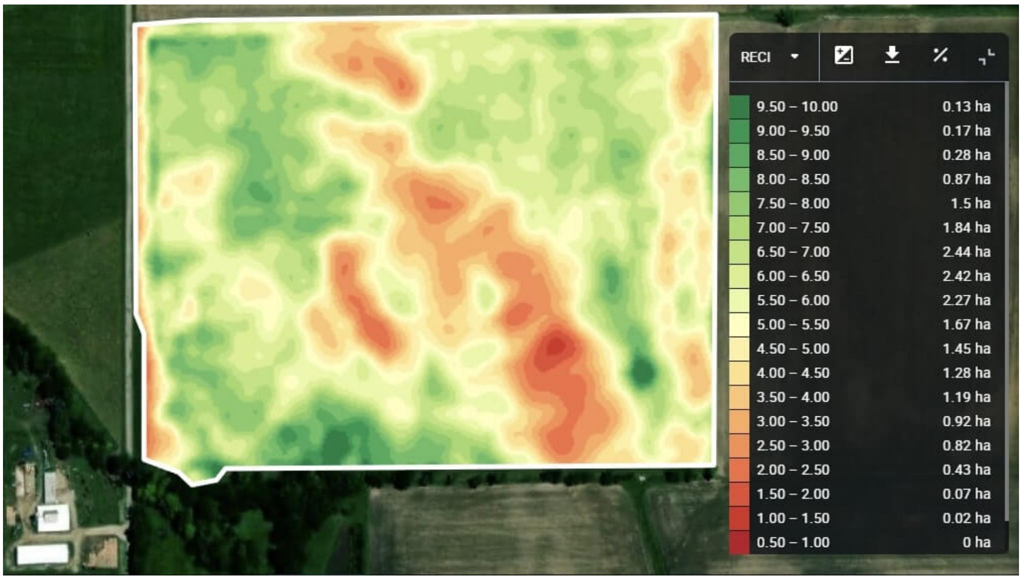
The ReCI vegetation index is responsive to chlorophyll content in leaves that is nourished by nitrogen. ReCI shows the photosynthetic activity of the canopy cover. In particular, the red-edge chlorophyll index was found to be an accurate and linear estimator of canopy chlorophyll and N-content and the Sentinel-2 bands are well positioned for deriving this index. The red-edge band is extremely sensitive to the light reflected off the cellular structure of a plant. Brighter reflectance corresponds to a larger number of plant cells and, by extrapolation, to the greener area.

$$Red\,Edge\ =\ \left(\frac{NIR}{RED}\right) - 1$$

Sentinel-2:

$$Red\,Edge\ =\ \left(\frac{B7}{B5}\right) - 1$$

Chlorophyll content directly depends on nitrogen level in plants, responsible for their “greenness,” this vegetation index in remote sensing helps detect areas with yellow or shed foliage. Vegetation map below clearly shows the field divided into several vegetative zones based on the ReCl index values of each area. Values 0 through 5 may indicate plants with a low level of photosynthesis.



Red edge are most useful at the stage of active vegetation development but are not suitable for the season of harvesting.

3.2.4 Normalized Multi-Band Drought Index

Normalized Multi-band Drought Index (NMDI), is proposed for monitoring soil and vegetation moisture. Like the Normalized Difference Water Index, NMDI uses the 860 nm channel as the reference; instead of using a single liquid water absorption channel, however, it uses the difference between two liquid water absorption channels centered at 1640 nm and 2130 nm as the soil and vegetation moisture sensitive band. Analysis revealed that by combining information from multiple near infrared, and short-wave infrared channels, NMDI has enhanced the sensitivity to drought severity, and is well suited to estimate both soil and vegetation moisture. Typical soil reflectance spectra and satellite-acquired reflectance are used to validate the usefulness of NMDI. For bare soil or weakly vegetated areas, a pixel will be mapped as dry soil condition if the NMDI is ≥ 0.7, intermediate if NMDI is within the range of 0.6 to 0.7, and wet if NMDI is <0.6. While for heavily vegetated areas with Leaf Area Index (LAI) ≥ 2, the performance of NMDI is like NDWI and NDII. Therefore, by combining information from multiple NIR and SWIR channels, NMDI has enhanced the sensitivity to drought severity, and is well suited to estimate water content for both soil and vegetation.

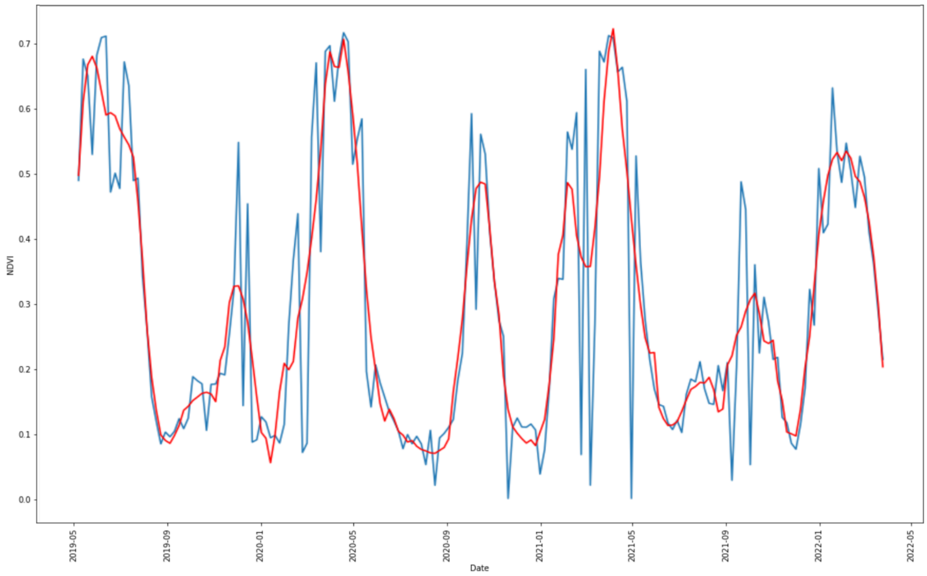
$$NMDI = \frac{(B8a-(B11-B12))}{(B8a+(B11-B12))}$$

3.3 FRCM Score - Methodology

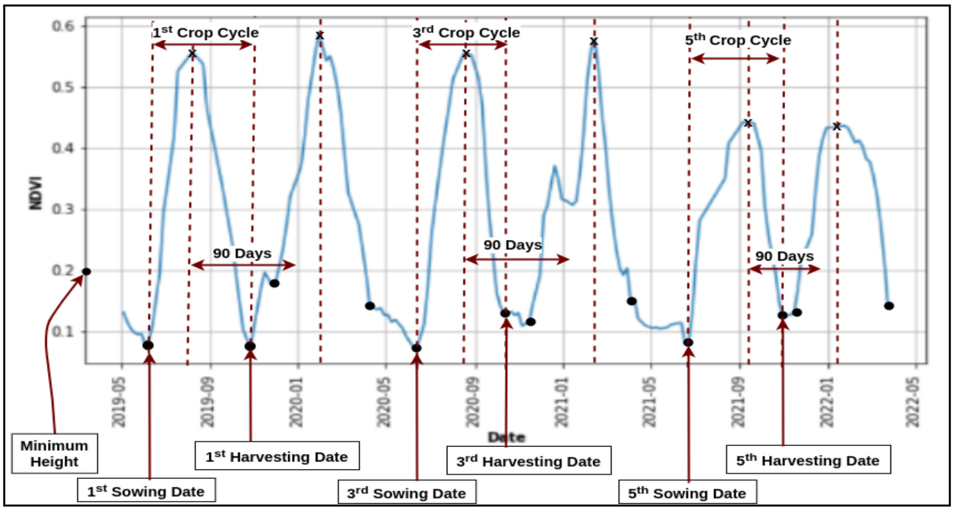
The proposed methodology for FRCM score calculation is sub-divided into various components namely, average crop season per year, crop health during cultivation cycle, nutrition index during crop cycle, canopy moisture during crop cycle, and soil moisture during crop cycle.

3.3.1 Average Crop Season per year

Average crop season per year is defining the weather conditions, irrigation source for agricultural fields. Average crop season depends on the source of irrigation e.g., canal system, pond, and other irrigation sources for cultivating crops. For getting the average crop season per year NDVI time-series data are utilizing over the field. Savitzky-Golay filter is used for smoothing the timeseries NDVI values, which helps in getting the crop cultivation for that field.



NDVI values for different crop types vary from 0.2 to 0.8. Minimum height of 0.2 NDVI value indicates that there has been some crop grown. In ideal condition a year has three cropping seasons – rabi, kharif and zaid. The distance between the two peak heights should be at least 90 days, so that unwanted peaks can be ignored. From the graph, the highest value of NDVI of that season indicates a peak, left-side of maximum dip indicates sowing time and right-side maximum dip indicates harvesting time for that season as shown in figure below.



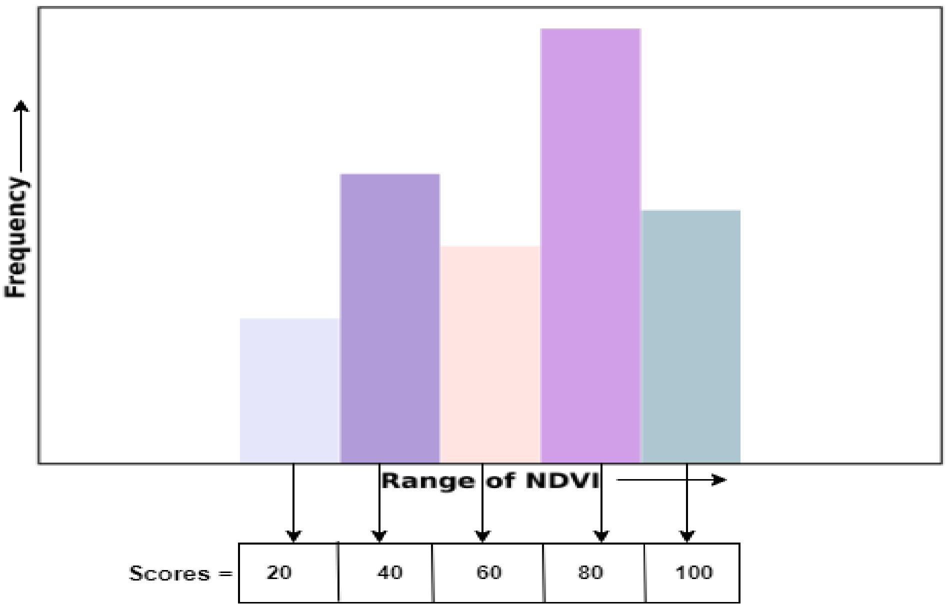
Now, to compute the average number of crop seasons per annum we are dividing the all number of peaks detected in time series NDVI values by 6 (Assuming 2 crop seasons per annum).

$$Average\ number\ of\ season\ per\ annum\ =\ number\ of\ peaks\ in\ NDVI\ spectra \div 6$$

$$Crop\ Season\ Score\ (A)\ =\ Average\ number\ of\ season\ per\ annum \times 100$$

3.3.2 Crop Health During Crop Season

NDVI is a measure of the state of crop health based on how the crop reflects light at certain frequencies. NDVI time series data over the polygon index field are utilized to compute health scores. The NDVI values of all pixels in agricultural plots on a date in season are taken and analyzed for outliers. This NDVI value will help to determine the status of the crop. To determine health status, for a single date we have plotted frequencies of all NDVI values in 5 buckets in increasing order. Now each bucket is assigned with a score as shown in the figure below.



In this way, on each 5 day interval in a season sowing month to harvesting month we had score and aggregate score for season is computed by taking average for all dates.

$$Crop\ health\ Score\ (B)\ =\ Score\ corresponding\ to\ minimum\ frequency\ bucket$$

3.3.3 Nutrition Index During Crop Cycle

Red Edge Vegetation index is used for estimating nutrition status in canopy during crop cycle. Red edge refers to the region of rapid change in reflectance of vegetation in the near infrared range of the electromagnetic spectrum. Red edge is a method of measuring the amount of chlorophyll in the plant. In general, Red Edge vegetation index has a greater correlation with canopy nitrogen content These Red Edge values of all pixels in agricultural plots on a date in a season are taken and analyzed for outliers. These Red Edge values will help to determine the nutrition of the crop. To determine nutrition index during the crop cycle, we have plotted frequencies of all Red Edge values in 5 buckets in increasing order.

$$Nutrition\ Score\ (C)\ =\ Score\ corresponding\ to\ i\ mum\ frequency\ bucket$$

3.3.4 Canopy Moisture During Crop Cycle

NDMI is used for canopy moisture detection during crop cycle. NDMI detects moisture levels in vegetation. NDMI is a reliable indicator of water stress in crops. NDMI time series data are utilized over the polygon index field. These NDMI values of all pixels in agricultural plots on a date in a season are taken and analyzed for outliers. These NDMI values will help to determine the canopy moisture during the crop cycle. To determine canopy moisture during the crop cycle, we have plotted frequencies of all NDMI values in 5 buckets in increasing order.

$$Canopy\ Moisture\ Score\ (D)\ =\ Score\ corresponding\ to\ i\ mum\ frequency\ bucket$$

3.3.5 Soil Moisture During Crop Cycle

NMDI has enhanced the sensitivity to drought severity, and is well suited for estimating both soil and vegetation moisture. NMDI is extremely sensitive to bare or weak vegetation, heavy vegetation and mixture of soil and vegetation. These NMDI values of all pixels in agricultural plots on a date in a season are taken and analyzed for outliers. These NMDI values will help to determine the soil moisture during the crop cycle. To determine soil moisture during the crop cycle, we have plotted frequencies of all NMDI values in 5 buckets in increasing order.

$$Soil\ Moisture\ Score\ (E)\ =\ Score\ corresponding\ to\ i\ mum\ frequency\ bucket$$

3.3.6 FRCM Score

FRCM score is the aggregate weighted average score of all five components as shown in below formula. The weights for average crop season per year, crop health, nutrition status, canopy moisture and soil moisture during crop cycle are 40, 20, 15, 15 and 10, respectively.

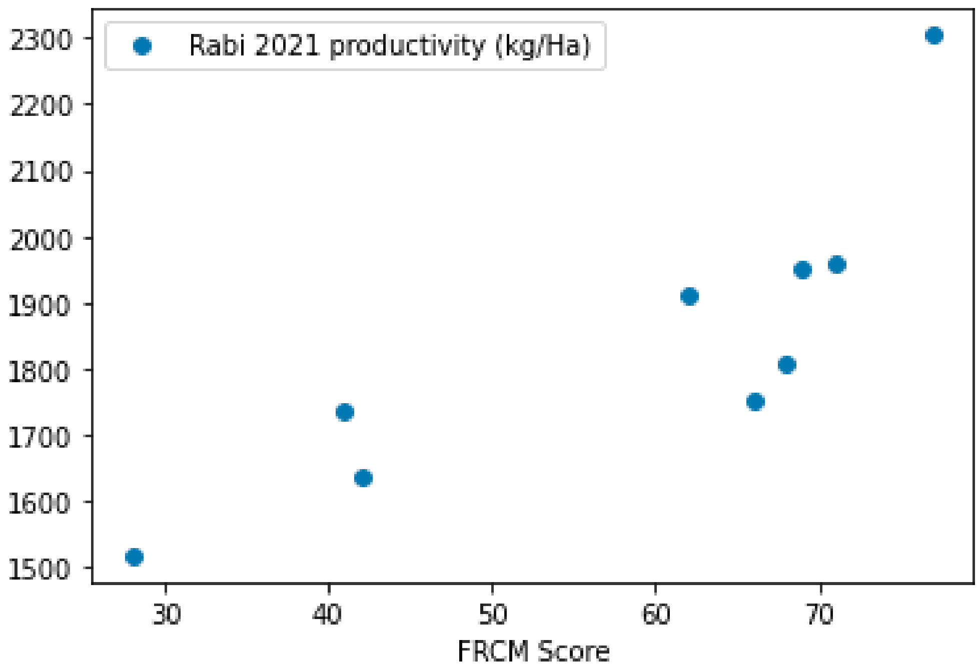
$$FRCM\ Score\ =\ Score(A) + Score(B) + Score(C) + Score(D) + Score(E)$$

4. Validation:

Datasets: To validate FRCM score we have chosen a few farmers from Chandhan (Jaisalmer) having cultivated mustard crop during rabi 2021 season. Rabi season usually starts sowing in the month of October first week to November last week and harvests start in the month of march.

	Farmer ID	Farmer Name	FRCM Score	Rabi 2021 productivity (kg/Ha)
0	RJ086092FA84956	Sukha ram	41	1734.68
1	RJ086092FA50133	Dhudi devi	42	1637.32
2	RJ086092FA85940	Sugnee Devi	62	1909.53
3	RJ086092FA03569	Padama ram	66	1752.77
4	RJ086092FA34844	Amb singh	68	1808.96
5	RJ086092FA04803	Kalyan Singh	69	1951.47
6	RJ086092FA34687	Dadu ram	71	1957.89
7	RJ086092FA64734	SATAR KHAN	77	2304.22
8	RJ086092FA08575	Bhim Singh	28	1517.28

Table shows FRCM score and Rabi 2021 mustard productivity in kg/Ha against each farmer. A scatter plot of the two variables is created. We know there is a relationship between the two variables. This is clear when we review the generated scatter plot where we can see an increasing trend shows positive correlation.



Pearson's correlation coefficient to summarize the linear relationship between two variables. Pearson's correlation coefficient between FRCM score and rabi 2021 productivity found to be 0.835.