ASSESSMENT OF SOIL QUALITY THROUGH NDVI-INDEX AT SC AGRO MIXT SPINENI SRL, IASI, ROMANIA

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Abstract

Precision agriculture is a management strategy that aims to optimize soil resources, water, and chemical inputs to obtain high and quality yields, improve environmental protection, and increase the agricultural system's sustainability. In precision agriculture, satellite images are particular tools that provide information about the areas covered with vegetation from which different structural indices of vegetation can be calculated. The objective of this research was to develop a variable fertilization map based on crop health status and the Normalized Difference Vegetation Index (NDVI). The results obtained show that the NDVI values depend on soil properties and fertility, weather conditions, crop technologies and degree of biomass development. The average values of NDVI index between 0.18-0.84 indicate a healthy crop, which determines the plant's normal conditions given by the concentration and balanced ratio between the main nutritional elements which correlates with high and quality crops. The use of satellite images in crop monitoring will lead to improve life quality and environmental protection and optimize soil, water and nutrient resources.

Key words: NDVI, satellite images, plant growth, soil properties

Crop increase and environmental impact minimization are challenges of the 21st century. Thus, practicing precision agriculture is the most important step toward making the agricultural process more efficient. The increased needs for food are ensured through the production quality and yield maximizing corroborated with increased doses of fertilizers and pesticide use.

Due to climate change, and with technological, chemical and biological changes occurring at the level of the agroecosystem, is necessary a precise and dynamic knowledge of soil resources with the state of crops vegetation (Zhang H. *et al*, 2018). Based on the identified needs, plants can receive the optimum amount of water, fertilizers and pesticides. The continuous monitoring of the crop vegetation state allows interventions to be carried out in real-time, in the place where it is necessary for the optimal period and in the necessary quantity. Thus, precision agriculture represents the most intelligent agricultural management system and involves the use of various tools and digital technologies that allow precise monitoring of crops, cost reduction, and quality of crops (Atik M. *et al*, 2020). The Normalized Vegetation Difference Index (NDVI) is frequently applied in the assessment of vegetation temporal changes and is considered one of the most significant indicators applied to exhibit vegetation status (Felegari S. *et al*, 2022). The calculated value of this index ranges from -1 to +1 where the absence of vegetation is indicated through negative NDVI values. For numerical values of NDVI is used the variations of near- and infrared bands wavelengths which are dependent on the state of the vegetation (Mandal V.P. *et al*, 2020, Rani M. *et al*, 2020). The NDVI has been used to evaluate the primary impact of soil properties on biomass and phenological stages of vegetation due to the strong bond between vegetation health and the content of available and accessible macro and micro-nutrients. Numerous variables, including plant structure and height, species diversity, environmental conditions, and landscape have an impact on this numerical parameter. Understanding the greenness of plants through each stage of growth provides significant advantages in terms of what to apply and the optimal practices for the study area.

The importance of soil macronutrient content and fertility in 0-20 cm depth is generally acknowledged in agriculture. Soil control supply is required to understand and estimate the soil nutrient content and vegetation plant stage interactions.

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The fundamental of the NDVI index is to maximize the data provided by spectral reflection and to reduce the morphological impacts of landscape and atmosphere. Due to rapid knowledge of vegetation change, the NDVI technique is favorable to conventional approaches in research across large regions. Particularly, vegetation index information derived from satellite images provides significant benefits for physiological process monitoring (Atik M. *et al*, 2022). The goal of this study is to assess the connection between variation in NDVI index with soil heterogeneity in order to develop a variable fertilization map based on crop health status.

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Figure 1 **General view of the research area**

MATERIAL AND METHOD

The research was carried out in a wheat crop at **SC AGRO MIXT SPINENI SRL,** Iasi, Romania (*figure 1*). The wheat variety was Glosa which is mostly used in the area.

The NDVI readings were made with Wingtra One system, which uses red and near-infrared (NIR) light bands that reflect the differences in the plant development stage. During photosynthesis, red light is absorbed by plants as s source of energy. A healthy plant reflects NIR light to a large extent and absorbs greater red light. Fig. 2 shows the high absorbance of a healthy plant in the upcoming wavelengths to red and blue colour. However, it reflects much of the NIR infrared, which is invisible to the human eye.

NDVI index is among the most used parameter in green vegetation monitoring, calculated from the bands that detect NIR and red light wavelengths (equation 1):

$$NDVI = (NIR-RED)/NIR+RED$$

Where, NDVI = normalized difference vegetation index

NIR – spectral reflectance of NIR wavelength of the light spectrum 0.67-0.78 µm

RED - spectral reflectance of RED wavelength of the red light spectrum 0.61-0.68 µm.

The values of NDVI index range from -1 to +1 with soil, water, clouds and snow having low (negative) NDVI index values, while green plants have index values that reach +1. The NDVI values are near to zero when there is poor vegetation. Low NDVI values on the NDVI map of agriculture-intensive areas cover areas with poor plant development including a variety of factors: soil heterogeneity, drought, excess or deficit of humidity, and diseases.

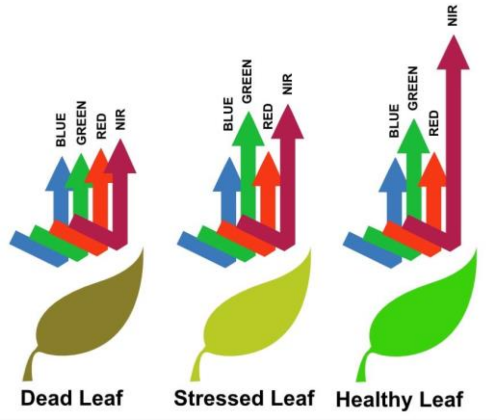

Figure 2 **Vegetation indices with the percentage of radiations emitted**
(https://physicsopenlab.org/2017/01/30/ndvi-index/)

Agricultural areas with high NDVI index reflect healthy plant growth.

RESULTS AND DISCUSSIONS

The values of NDVI index are related to plant chlorophyll intensity and vegetation cover (Essaadia A. *et al*, 2023). The two spectral reflectances at wavelengths of 655-665 nm and 835-865 nm were used in the NDVI computation.

The assessment and interpretation of NDVI value is particularly informative. It provides the quick identification of problematic fields and varies according to the variety and phenological stage of the crop (*table 1*).

Table 1

Interpretation of NDVI values

NDVI value	Assessment
<0.1	Uncovered soil
0.1-0.2	Almost absent vegetation cover
0.2-0.3	Very low vegetation cover
0.3-0.4	Low vegetation cover
0.4-0.5	Mid-low vegetation cover
0.5-0.6	Average vegetation cover
0.6-0.7	Mid-high vegetation cover
0.7-0.8	High vegetation cover
0.8-0.9	Very high vegetation cover
0.9-1.0	Total vegetation cover

Fig. 3 shows the evolution and dynamic of the NDVI index based on the density of vegetation cover. In the context of wheat crops, a mosaic appearance was observed, with different green colors between 0.18-0.84. The average value of NDVI = 0.61 for the wheat crop, which indicates healthy and dense vegetation. Low values of the NDVI index suggest fields without crops, whereas high values indicate orchards, forests, or crops (Mohajane M. *et al*, 2018). According to the results obtained by Modica G. *et al*, 2016, the negative values of NDVI index (which are the minimum values) reflect the presence of snow while the maximum values, higher than 0.7 reflect the density of vegetation in crops and forests.

characteristics and properties, soils with a medium texture, high humus content, accessible forms of nitrogen, phosphorus, and potassium and a pH between 6.8-7.2 provide the optimal wheat development conditions leading to higher NDVI values.

As indicated by the values of standard deviation SD=0.19, the wheat plants density appears to vary significantly. This may indicate an absence of plant distribution, variation in plant health, or differences in soil fertility.

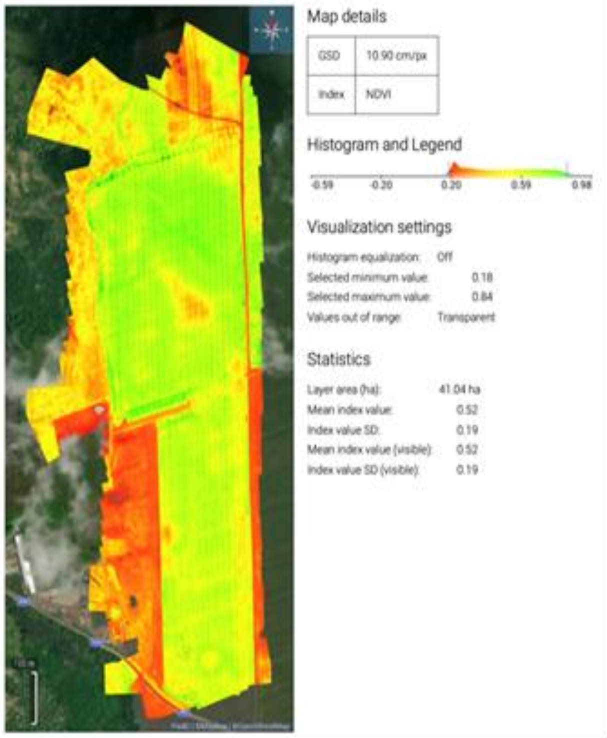

Fig. 3 **NDVI image for wheat crop within SC AGRO MIXT SPINENI SRL**

Table 2

Soil chemical properties

	pH		P accesible, ppm		K accesible, ppm		Humus %
Value	Minim	Maxim	Minim	Maxim	Minim	Maxim	3.9
	6.9	7.9	25	36	253	314	
	Neutral	Alkaline	Medium	Medium	Very good	Very good	Medium
Average	7.2		30		290		
	Neutral		Medium		Very good		

Generally, NDVI values greater than 0.4 are considered optimal for crops, and a value of 0.52 suggests that wheat plants due to weather and soil conditions are developing optimally at this stage. These values are associated with a high and healthy plant biomass in conjunction with a high content of macro and microelements. The favorable physical conditions such as texture, and the optimum soil humidity allowed the root system to develop in the superficial layer of the 0-20 cm soil depth. Being a sensitive plant in terms of soil

The values of NDVI index correlate with the chemical properties of the soil where the content of accessible macro and micronutrients is good and very good (Table 2). Thus, the study area has a medium content of nutrients, with an optimal content of phosphorus and relatively high potassium.

The pH values determined in aqueous suspension by the potentiometric method indicate a neutral reaction. The neutral soil pH values determine optimal conditions for the development of wheat plants during which the basic elements, nitrogen, phosphorus and potassium are in optimum equilibrium and assimilated by the plants.

CONCLUSIONS

The results obtained show wheat healthy vegetation with significant variation in plant density throughout the study plot. The NDVI values correlate with soil macronutrient content and heterogeneity, leaf area index, and percentage of land covered by vegetation and photosynthetic activity. To optimize crop yield and health, it is important to investigate the causes of variation and address identified problems, such as variable fertilization, diseases and pest control or improve farming practices. Continuous monitoring of NDVI index throughout the growing season can help identify and address problems in a timely manner.

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