USE OF REMOTE SENSING IMAGES FOR THE IDENTIFICATION OF N0-TILL SEEDING PLOTS

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INTRODUCTION

Agriculture and Climate Change (CC) are intimately related. Therefore, Conservation Agriculture (CA) can contribute to the global challenge of mitigating the effects of CC, as stated in the report "Benefits of Conservation Agriculture in a Climate Change Environment (Gil Ribes et al., 2017)". In this context, FAO is also aware of the importance of preserving agricultural soils, which is why it has published the "Voluntary Guidelines for Sustainable Soil Management" (FAO, 2017).

The future Climate Change Act may also be an opportunity for Conservation Agriculture. One of the major commitments made by the Government for the present legislature is the drafting of the Climate Change and Energy Transition Act. That is why on May 25th and 26th 2017 the "Spain, together for climate. Climate Change and Energy Transition Law" discussion days were organized. Among the many experts who came together those days, the Spanish Association of Conservation Agriculture Living Soils (AEAC.SV) actively participated with the assistance of its president, Mr. Jesus Gil, in two of the working sessions related to Agriculture and strategies for mitigation and adaptation to climate change.

In Europe, agriculture is the fourth ranking activity in the emission of Greenhouse Gases (GHG) with around 10% of total production, behind the sectors associated with energy, transport and industrial combustion.

To put a stop to this escalation of emissions, at the end of 2015, the 21st session of the Conference of the Parties (COP21) was held in France. The session concluded with the adoption of a historic agreement to combat climate change and promote measures and investments for a low-carbon, resilient and sustainable future, the so-called Paris Agreement.

On November 30th 2016, the Spanish Parliament unanimously agreed to ratify the Paris Agreement in the fight for climate change, which marks the beginning of a series of structural reforms.

Within the COP 21 framework, Spain has joined the "**4 per one thousand**" initiative originally launched by the French government. The national commitment to the initiative will be dedicated to improving the soil organic carbon content by 0.4 per cent.

Agriculture is, without a doubt, a productive activity, which depends directly on climate and its variability. A change in the behavior patterns of temperatures and rainfall or an increase in the concentration of atmospheric CO2 will significantly affect crop development. It is estimated that, at a global level, climate variability is responsible for between 32% and 39% of variability in yields, an effect which increases in regions such as the one occupied by the Iberian Peninsula.

On the other hand, as part of the negotiation for the Common Agricultural Policy (CAP) Reform for the new Horizon CAP 2020, new fulfilments related to soil protection are expected to appear. Those fulfilments could be within Pillar 1, considering soil protection as another assumption within *greening*, or through Pillar 2, as horizontal measures of CA in arable and woody crops in the rural development programs of the Autonomous Regions to help farmers during the transition stage.

Conservation Agriculture is one of the most studied and developed Agricultural Sciences in the world today. According to FAO, it is practiced in almost 160 million hectares. At present, Spain leads Europe, with almost 2 million hectares.

Most of the area in CA corresponds to cover crop in perennials, occupying 1.3 million hectares, which represents 26% of woody crops soil. The agricultural surface under No-till seeding occupies more than 0.62 million hectares (ESYRCE-Subdirección General de Estadística, 2016).

In Spain, the area allocated to CA is gradually increasing, but we still need the trigger that will make its practice rise to the level of leading countries such as Argentina, Brazil or the United States. The adoption process is slow and long for reasons related to willingness more than to agricultural technology.

In view of these new agro-environmental scenarios, **a significant increase in the area managed under CA principles is expected over the next few years**. Up to now, the increase has been constant but modest since there was not much institutional support. For this reason, **large-scale monitoring and control systems will be necessary to enable the administration to supervise, quickly and efficiently, those plots that have acquired a series of commitments related to CA.**

The Association of Conservation Agriculture in Albacete (ASALBAC), integrated within the AEAC.SV, together with the Remote Sensing and GIS section of the Regional Development Institute of the University of Castilla-La Mancha has been trying to find a way, for some time, to integrate the use of Remote Sensing and CA. This interest led one of the members of ASALBAC to develop a methodology for the classification of plots in No-till seeding by using time series of remote sensing images.

The use of time series of satellite images opens the door to the development of a tool for the identification, follow-up and control of plots managed under No-till seeding systems (Brox Moreno, 2017).

HOW CAN WE DIFFERENTIATE CULTIVATED FROM UNCULTIVATED PLOTS?

The vegetation indexes obtained from the processing of satellite images have different values, depending on whether we measure bare soil or soil covered by crop debris and weeds remaining from the previous harvest.

One of the most commonly used indexes in remote sensing is NDVI (Normalized Difference Vegetation Index) (Rouse et al., 1974), which is obtained from the reflectivity of the red and near-infrared bands. In the case of Sentinel-2A satellite, the red band would be band 4 and the near-infrared band would be band 8.

Figure 1 shows a comparison of the bands observed on Landsat 7, Landsat 8 and Sentinel 2 satellites.

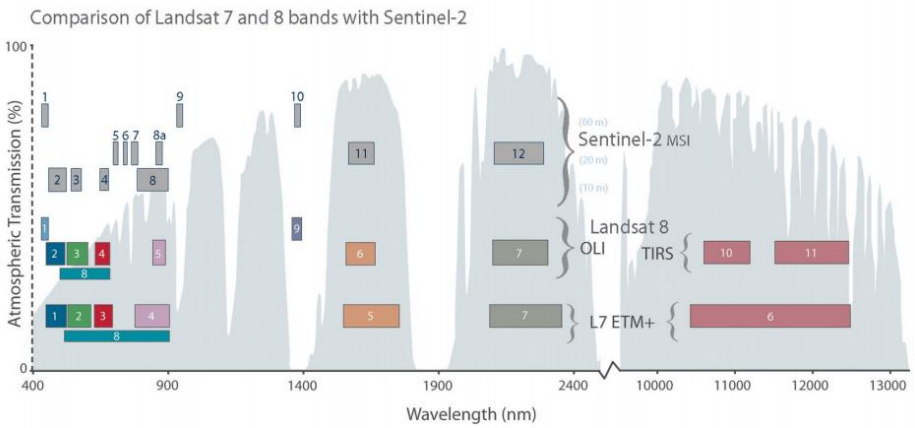

Figure 1. Comparison of Landsat 7 and 8 bands with Sentinel-2. Source: Documentation Specialist Course on Remote Sensing and GIS 2016. Remote Sensing and GIS Group. University of Castilla-La Mancha.

In the process of NDVI calculation and treatment of the images, the methodology described by (Campos et al., 2011) is used, where a series of corrections and absolute normalization of each image are described.

NDVI measures the photosynthetically active size of the biomass covering the soil. This index usually has a value of about 0.15 for bare soil and about 0.2 (or above) in no-till seeding plots where the debris of the previous crop are left covering the soil, as can be seen in figures 2 and 3. These NDVI differences between bare soil and soil covered with previous crop debris are the key to proposing a classification methodology.

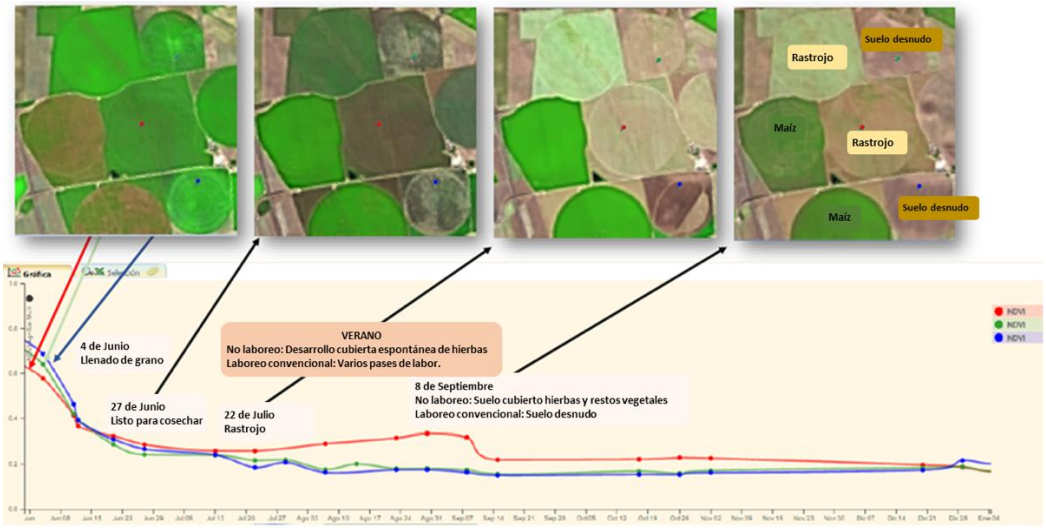

Figure 2. Comparison of NDVI of soil in summer for NT and tillage plots. Source: Agrisat.es

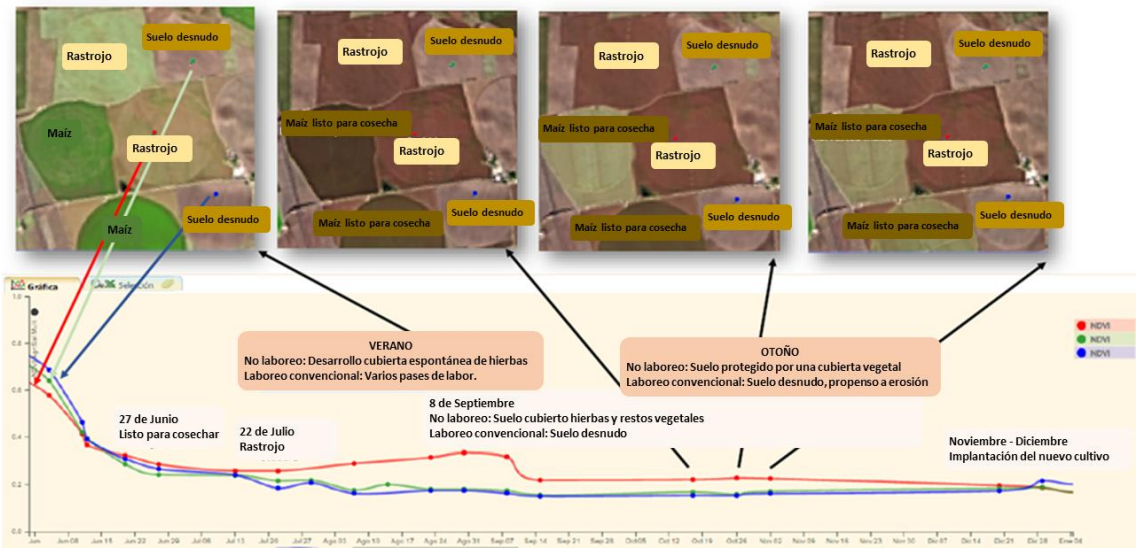

Figure 3. Comparison of NDVI of soil in autumn for NT and tillage plots. Source: Agrisat.es

WHERE TO PROPOSE THE METHODOLOGY?

ASALBAC is aware of a large area and number of plots managed in NT seeding in a work zone within the Mancha Oriental Aquifer. This knowledge has been fundamental in the development of a methodology for the identification, monitoring and control of plots in NT seeding. There are irrigated farms such as Casa Jara (see figure 4), in the municipality of Tarazona de la Mancha (Albacete), and dry farms such as Casa Roig, in Alpera (Albacete), where No-till seeding has been practiced for more than 15 years. For this reason, they have been used as training plots in order to extend the methodology to the rest of the areas covered by the surface of the scene observed by Sentinel 2A satellite within the study area.

Figure 4. Parcelas entrenamiento en Finca Casa Jara(S/E)

In addition to the training area, other well-known areas, where NT seeding is practiced, have also been used. In those plots, the results obtained in the training area were contrasted.

HOW TO MAKE A CLASSIFICATION MAP FOR LARGE AREAS?

The proposed methodology consists of starting from the classification of crops generated in the ERMOT project (Evolution of Irrigation in the Mancha Oriental Aquifer by Remote Sensing). In this classification, a type of crop is selected and a new classification of those crops is made, according to the temporal evolution of NDVI in the months prior to seeding. The new classification consists in the selection of those pixels with NDVI values greater than 0.2 in the images obtained through the Sentinel 2A satellite (see figure 5). The pixels that meet those conditions will, in principle, be part of those plots managed with No-till seeding.

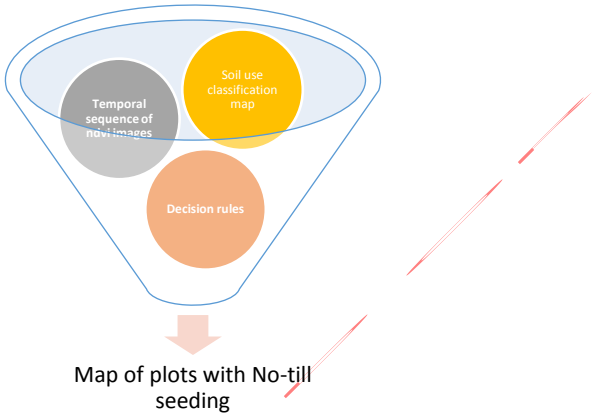

Figure 5. Classification methodology.

SOIL USE CLASSIFICATION MAP.

The classification of crops generated in the ERMOT project is elaborated by the Remote Sensing and GIS section of the University of Castilla La Mancha. It is based on the knowledge of vegetation cover or existing crops in certain areas, called training plots. This knowledge allows assigning the characteristics that will distinguish the different types present in the study area. The NDVI bands of the image are used for classification.

At the end of the whole process, a land use map is obtained, as shown in figure 6, where the crops present in the study area are classified. The classification in the image is based on colors, where each color is associated with the type specified in the legend of the image.

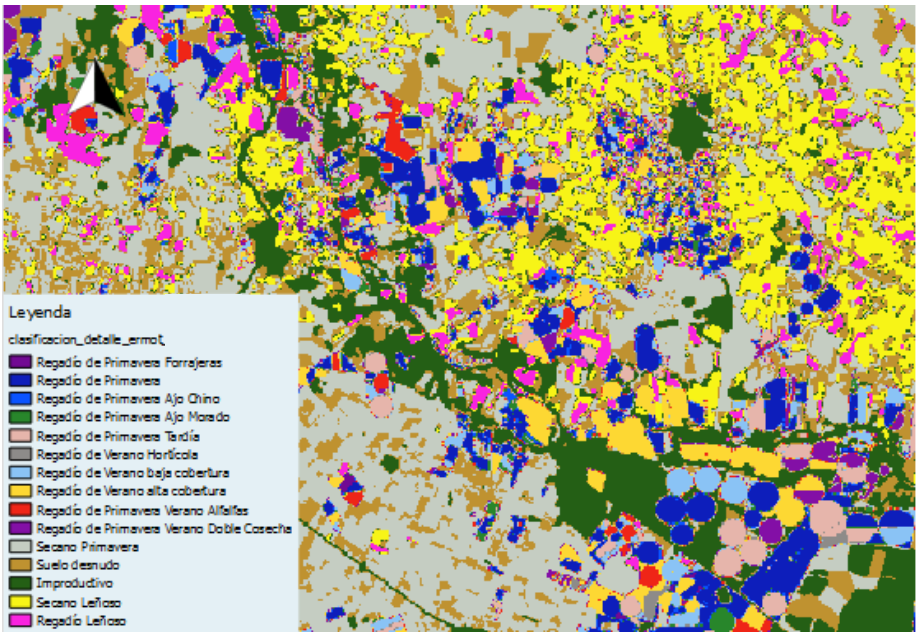

Figure 6. Clasificación ERMOT (S/E).

Once we have the classification of crops, the type of crop on which the proposed methodology will be used is extracted through a GIS (Geographic Information Management) software.

In figure 7, the plots that belong to the *Full Coverage Summer Irrigation* type are shown in orange.

Figure 7. Full Coverage Summer Irrigation type

TEMPORAL SEQUENCE OF NDVI IMAGES

Once a type of crop to be studied is extracted, a time series of NDVI images is used throughout the months prior to seeding.

The SPIDERwebGIS tool (www.spiderwebgis.org) is used to choose the images. This is a webGIS page where temporary sequences of remote sensing images are made available to the user for use in agronomic applications (see figure 8).

Good quality images, free of clouds and any other type of interference, should be chosen.

Figure 8. Sentinel 2A RGB image from February 4, 2016 without clouds

NDVI images (see figure 9) of the dates chosen for further processing are provided by the Remote Sensing and GIS Group of the University of Castilla-La Mancha.

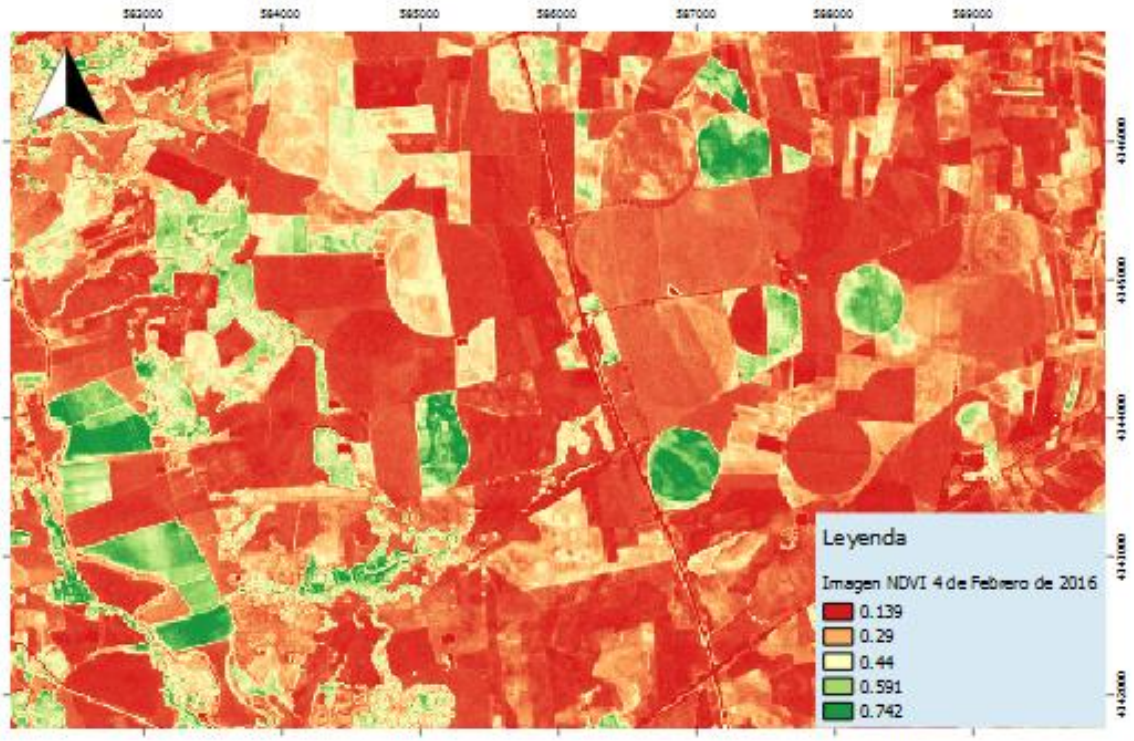

Figure 9. NDVI image from February 4, 2016 (S/E).

DECISION RULES

When classifying NDVI images in order to obtain the pixels associated to the parcels managed under NT seeding, some decision rules must be established. **The objective is to obtain those pixels that simultaneously comply with the rule established for the selected NDVI images, and at the same time, belong to the ERMOT type of crop to be studied.**

Figure 10 shows one of the classifications carried out, in which the training plots whose **pixels that meet the two established conditions are marked. Those conditions are: NDVI greater than 0.2 and ERMOT crop classification "Full Coverage Summer Irrigation".**

LARGE AREA CLASSIFICATION MAP

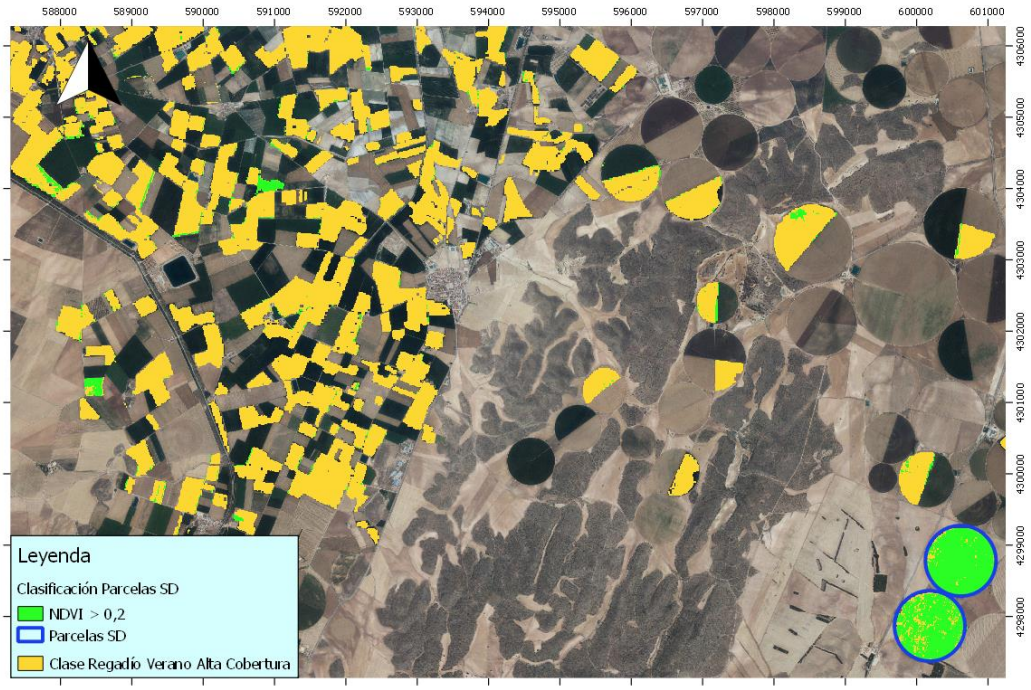

Figure 10. Pixel classification with NDVI > 0.2 (S/E).

In view of the results obtained, the proposed methodology could be valid when it comes to having a tool for subsequent monitoring and control with which to conduct a large scale of plots managed under No-till seeding.

CONCLUSIONS

Based on the results obtained in this work, it can be concluded that it is possible to use a methodology which allows for the study of large areas and the classification of those plots in NT seeding in order to monitor and control them.

Having a computer file with the census of plots in NT seeding of an area would help to make use of the proposed methodology more effective.

No-till seeding is considered to be the most powerful tool available to farmers when it comes to practicing more sustainable agriculture, protecting the agricultural environment from erosion and optimizing the resources needed for agricultural production.

No-till seeding is a technique practiced without any problems in extensive crops such as grains, legumes, oilseeds, ... However, there is still work to be done in very small seed crops (such as opium poppy) or horticultural crops.

In the future, the application of this methodology to determine the presence of vegetation cover in woody crops should also be evaluated.

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