SUMMARY

TITLE: „The monitoring of agropedoclimatic parameters in field crops through measurement and observation methods, using images collected from drones and satellites”

Keywords: *precision agriculture, drones, pixel classification, photogrammetry, remote sensing.*

The paper aims to bring forward modern methods of monitoring agricultural crops using tools such as GNSS receivers, GIS tools, drones, UAVs, intelligent sensors and satellites.

Modern measurement and monitoring tools help farmers in rationalizing production costs with the help of maps and plans obtained from aerial images. Orthophotos may contain information such as: crop uniformity, excess water, and other damage caused by extreme weather events. Hence, the deliverables offered to farmers can consist of: fertilization plans, phytosanitary management plans, the diagnosis of crops following the sowing or fertilization process, information on plant density (plant number and leaf volume), assessment of the degree of weeding and establishing the optimal time for weed control.

The advantages of farmers who use modern agricultural crop monitoring tools can be: optimizing resources by reducing water consumption, fertilizers and pesticides, reducing decision-making time, more efficient fertilization, maintaining the sustainability of farming systems, and increasing profit by generating bigger crops and higher quality.

The research was carried out on the following farms: SC Ildu SRL, SC Probstdorfer Saatzucht Romania SRL, SC Intercereal SA from Calarasi County and Belciugatele Didactic Station: USAMVB “Moara Domnească” farm. The research targeted the following crops: rapeseed, wheat and maize.

The thesis is structured in six chapters, each of them presenting the current international state of research in this field, followed by own research and descriptions of each scientific experience.

Chapter I presents: the objective of the thesis, general information and the international status of the studies conducted so far, focusing on the concept of "precision agriculture".

Chapter II describes the materials and methods used in the research. The study area, the characteristics of the drones and UAVs used, the air code legislation and the agrometeorological characterization of the study area are presented.

Chapter III presents the 7 experiences performed during the years of research, as follows:

Experiment 1. "The determination of the optimal flight altitude with the purpose of optimizing the evaluation of the rate of damage to rapeseed crops when leaving winter, using image processing" in which aerial images were taken at different altitudes using the Phantom 4 Professional drone, which then went through the the pixel classification process, thus obtaining the total area covered by the vegetation in relation to the total area. Therefore, the images taken over 150m altitude were validated, the optimal being taken at 50m altitude. This study was necessary in order to use the optimal altitude in future research.

Experiment 2. "The presentation of three modern processing methods of assessing the damage to rapeseed crops at the end of winter" using three modern methods of assessing the degree of deterioration of rapeseed crops at the end of winter, in comparison with the classic method. The first method involves using GNSS technology and the field capture method together with the "Stop and Go" method; For the second method, the manual digitization of affected areas using GIS tools is presented. The third method consists of classifying pixels using image processing software and custom scripts written in the Python programming language. All three studied methods are viable and have yielded good results, but the third method proves to be superior to the others at both speed and precision. This study was necessary to determine the most expeditious, efficient and accurate methods to be used in future research.

Experiment 3. "Research on the use of aerial images in estimating the yields of rapeseed crops" using two modern methods of aerial image processing acquired and correlated with the on-site measurements. The first method consists of taking pictures using the Phantom 3 Professional drone, creating the orthophoto and passing it through the classification process, resulting in 5 classes of different densities. The second method involves taking a satellite image of the area of interest on the same date, classifying it according to the same legend. The correlation of data obtained from classifying the images with the traditional method involved: counting the number of plants per unit area using the metric frame on the entire surface, making determinations such as the number of branches/plant, number of *silicve*, number of grains and grain mass. This process was repeated 5 times for each class identified in the images. In this case, it was found that the method using the orthophoto obtained from the drones was more efficient and the production estimation was very close to the actual one. At the same time, the orthophoto which resulted from the drones has a much better resolution than the satellite image, which also has high costs. Based on satellite imagery, differentiated fertilization plans can be drawn up, which is the subject of the next experience.

Experiment 4. "Comparison of modern satellite and UAV capture methods with the purpose of determining the degree of damage of rapeseed crops during winter" which presents the classical methodology of the data acquisition compared to the data acquired from satellite and from the UAV. After that, the farmer's deliverable is obtained: the differential distribution plan of the inputs. Both orthophotos have gone through the classification process following the same legend. In this case, both variants were viable for the purpose of determination of affected areas, with the observation that the method of assessing the degree of damage to crops using the images taken from the UAV was more accurate and closer to the classic estimate. The deliverable can be exported in "* .shp" format so that it can be directly inserted into the GPS.

Experiment 5. "Research on the potential of using image processing for assessing the state of corn crops". In this experience, the data obtained using classic instruments from field measurements on chlorophyll and Nitrogen content was correlated with the data obtained from the classification of aerial images corresponding to the NDVI vegetation index. The method has been validated by obtaining linear correlations between classic and modern measurements, so that a legend can be drawn up which can be used in similar future studies.

Experiment 6. "Research on the potential of using UAV imagery in preparing fertilization plans for wheat crops" using images from the SenseFly eBeeSQ UAV, based on which the management plan of fertilizers at the level of the whole plot is drawn up, as it showed uneven levels of fertility. Using the agrochemical cartography of the soil, correlations have been made between the position of the pixels and the value of soil nutrients.

Experiment 7. "Researches on the degree of damage to rapeseed culture following pest attacks, using the FAE FIXED WING UAV" which traces the diagnosis following the attack of the Phyllotreta atra pepper, on the basis of which the affected areas and the respective reforestation plans were determined with a spring culture.

Chapters IV, V and VI are the conclusions, recommendations, own contributions and bibliography of the thesis.