AGRI - TECH PROJECT

Plantation of grape vines , also known as vineyards, faces problems with diseases during their growing season Grapevine Leafroll Disease and its types, finding solutions. During the growing period of vineyards that ends in September/ October, vineyards experience issues of fungal and bacterial diseases that threaten its vitality and productivity. A healthy vineyard supports and produces quality wine, mouthwater grapes and balance in the overall ecosystem. This research looks at factors that influence vineyards health complexity and implementation of Technology to minimize and monitor the growth of vineyards and its contribution to the ecosystem.

Weather or climate change is one of the factors that affects plantation lifecycles and causes leaves, crops, stems and fruits to develop slowly. Other factors causing vineyards health includes soil quality and pest management. These diseases cause severe economical imbalance, productivity and profitability. According to Sarkakar. C., et al,. (2023), “Leaf disease is a kind of phenomenal hurdle in agribusiness but also responsible for hampering the agricultural production of the country”. The types of leafroll diseases devastate crops, fruit growth and quality. Understanding the fundamental types of vineyard diseases, including Black Rot, Esca, and Leaf Blight is important for implementation of effective management strategies using Technology.

Leafroll disease, caused by viruses, leads to delayed growth and reduced yield. Infected leaves demonstrate rot and yellowing, impacting photosynthesis and fruit maturation, and that affects growth and quality of fruit. According to Vanglund. I., (2021), he explains that “yellow oil spots appear on the vine leaves, which if untreated the disease can cover the entire leaf or the shoot. After warm and humid nights, whity downy fungal growth develops and spreads also to cover the grapes.

Black rot is a fungal disease characterized by dark, sunken lesions on the leaves and fruit cluster. It develops well in warm, humid conditions, leading to great yield loss if not managed and maintained through timely interventions such as fungicide application. Gupta. M., Vikram, A. and Bharat. N., (2013) defines black rot as a disease “caused by Xanthomonas compastris pv. Campestris (Pam.)”, and further explains that “the disease affects primarily above the ground parts of the plant at any stage of growth and causes high losses in yields and quality.”

Escar is one of the diseases that is affecting the grapevines and potentially devastates the economy as it decreases the yields, wine quality and fruit quality. The disease has been known to be effective since earlier than the 1980s and the disease has been observed ever since. The disease is primarily caused by Phaeoacremonium aloephilum and Phaeomoniella chlamydospora (both causing brown and black wood streaking) and white rot basidiomycete species such as fomitiporia mediterranea which cause wood rot in the trunks and arms of generally older grapevine (Graniti. A., Surico. G., and Mugnai. L. 2000).
Leaf Blight, caused by fungi, presents as brown black spots on leaves, leading to premature leaf drop. The disease reduces photosynthetic area and severely impacts the development of grape in conditions that favors fungal growth.

ANNOTATION STRATEGY

The objective of this project is to implement technological solutions that can identify grapevine diseases from images of grape leaves at an early state and prevent the growth of the disease to spread. This solution is done using deep learning, machine learning and data annotation structures, tools and techniques. Studies have been developed to “create the decision-support systems to be able to identify diseases appearing on vine leaves that could disrupt yields and quality if not treated early”, (Vanglund. I., 2021: pg: 5). The project compares different categories of diseases, stages and percentages of the impact of the disease to images without disease named healthy. The approach was to divide into three main parts, gathering images, dataset and subject research to implement data annotation using semantic labeling technique, python scripting and machine learning.

The first was to pull an image dataset from Mandal. R., (2023), from his kaggle website account. We collected more than 120 pictures of grape leaves from Mandal’s account and other various kaggle dataset accounts which we narrowed our dataset images to 100, classifying them into Black rot, Esca, Leaf Blight and Healthy categories. An initial annotation of images was made by Bruce Mutemula and Nico Nkosi using semantic, segmentation labeling, specifically using polygon and boundary marking technique to approach the task. This approach was useful for tasks that require precise location data and providing content descriptive information about the

vineyard leafroll affected leaves images, which aid in accessibility, searchability and manageability of the task. CVAT (Computer Vision Annotation Tool) was used for this approach because of its popularity, as a tool that can accurately annotate images and video annotation, particularly in machine learning and computer vision projects. CVAT's additional benefit to approach the project was its functionalities for collaboration, user-friendly, flexibility and the ability to capacitate the amount of datasets used.

After the annotating process, we successfully converted our task in a xml file, XML provides a clear structure, making it easy to organize and represent complex data like annotations, labels, and attributes and XML files are text-based and can be easily read and edited by humans, converted and simplifying file modification for annotations and python scripting.

We completed the conversion and downloaded the csv file for data analysis. The data was scattered and uncleaned, it needed more polishing and cleaning. A python script was then done to re-organise the data in tabular format for further use of python scripting, a task that was assigned to Matimu Nghonyama with the assistance of Nico Nkosi. We used python to organize data, rename and move dataset images to new directories and performed python scripting for exploratory data analysis, distribution leaves conditions and leaves area affected by disease. (see below figures).

Fig 1 - Distribution of leaves Analysis

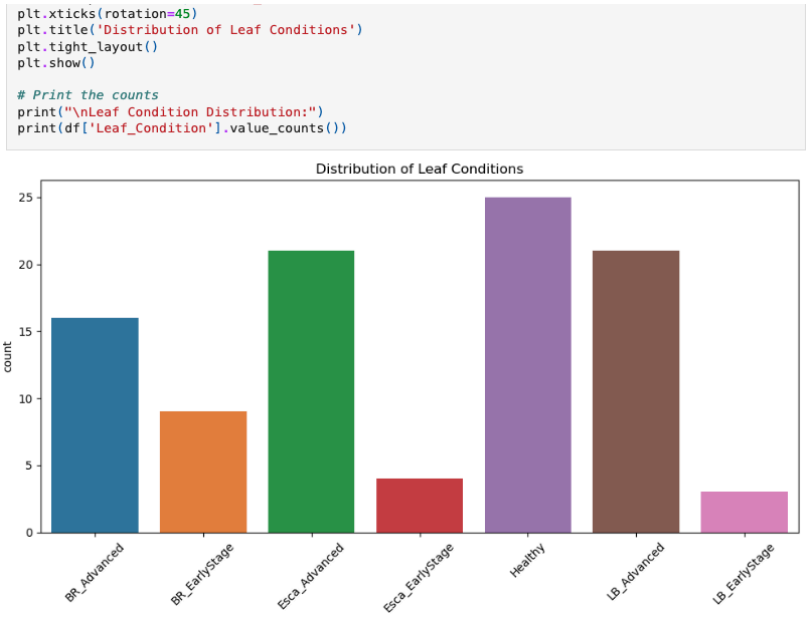


Fig 2 - Leaves Area affected by Condition

```
In [8]:
# Distribution of Leaf Area Affected
plt.figure(figsize=(10, 6))
sns.boxplot(x='Leaf_Condition', y='Leaf Area Affected(%)', data=df)
plt.xticks(rotation=45)
plt.title('Leaf Area Affected by Condition')
plt.tight_layout()
plt.show()
```

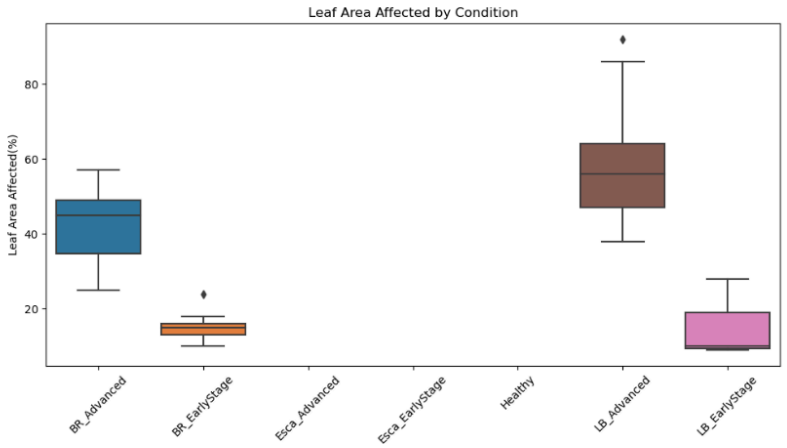
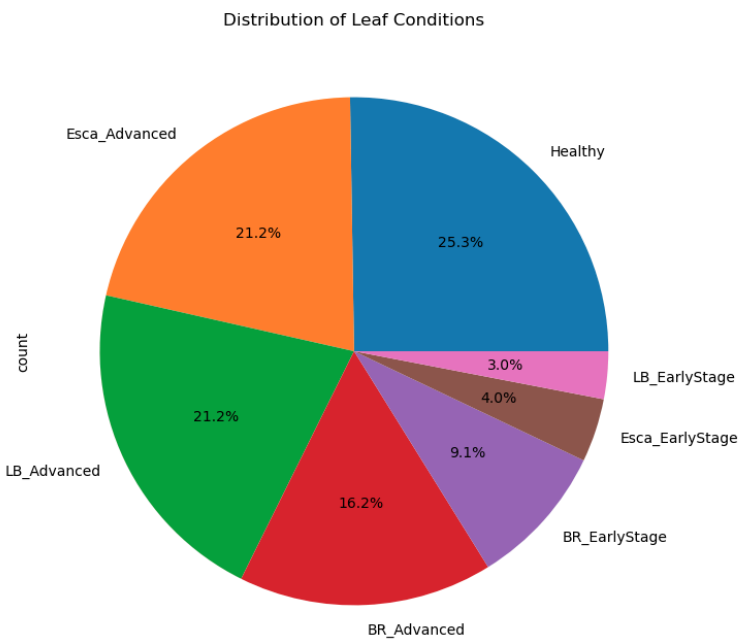


Fig 3 - Distribution of leaves Condition



CONCLUSION

The role of technology in disease agriculture, specifically in the landscape of vineyard disease management by integrating Deep Learning, Machine Learning, Data Annotation, Internet of Things, Sensors and other Artificial Intelligence applications. These advancements in technology application empowers vineyards growers and owners to detect and address diseases by enhancing health, growth and productivity.

Data Annotation plays an important role in training machine learning models by labeling image diseases accurately, resulting in better solution, detection and accurate information to manage diseases. Machine Learning algorithms help to analyze disease data and predict the outbreak by identifying patterns and trends provided to it to improve decision making and enabling timely intervention to manage diseases effectively. AI will utilize information from multiple sources, including imagery, sensors, drones and other advanced technologies for application of precise monitoring and treatment to drastically reduce infection and improve quality.

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