REAL TIME WEED DETECTION IN PRECISION AGRICULTURE

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[B div – 3474]
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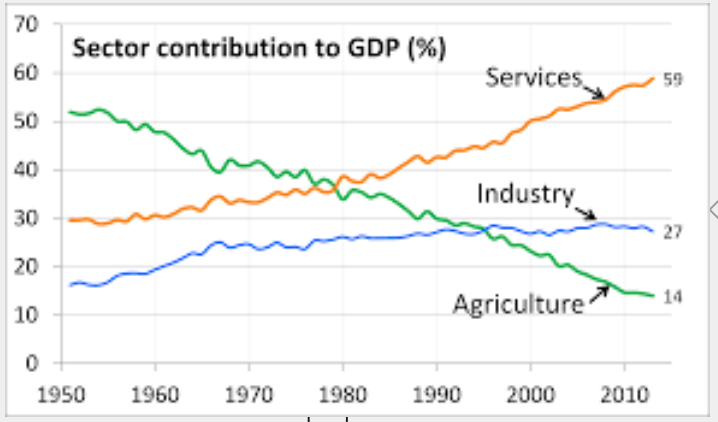
AGENDA

- IMPORTANCE OF AGRICULTURE?
- CHALLENGES FACED BY AGRICULTURE.
- WHAT ARE WEEDS?
- WHY WEED MANAGEMENT IN AGRICULTURE IS IMPORTANT?
- WHY WEED MANAGEMENT IS DIFFICULT?
- PRECISION AGRICULTURE
- PRECISION AGRICULTURE IN WEED MANAGEMENT
- RESOURCES

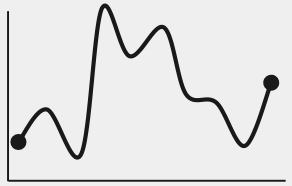
WHY AGRICULTURE IS IMPORTANT?

Agriculture plays a critical role in the entire life.

Agriculture is the backbone of the economic system of a given country.



It accounts for more than 15% of the gross domestic product.
It ensures food security for the country and produces several raw materials for industries.

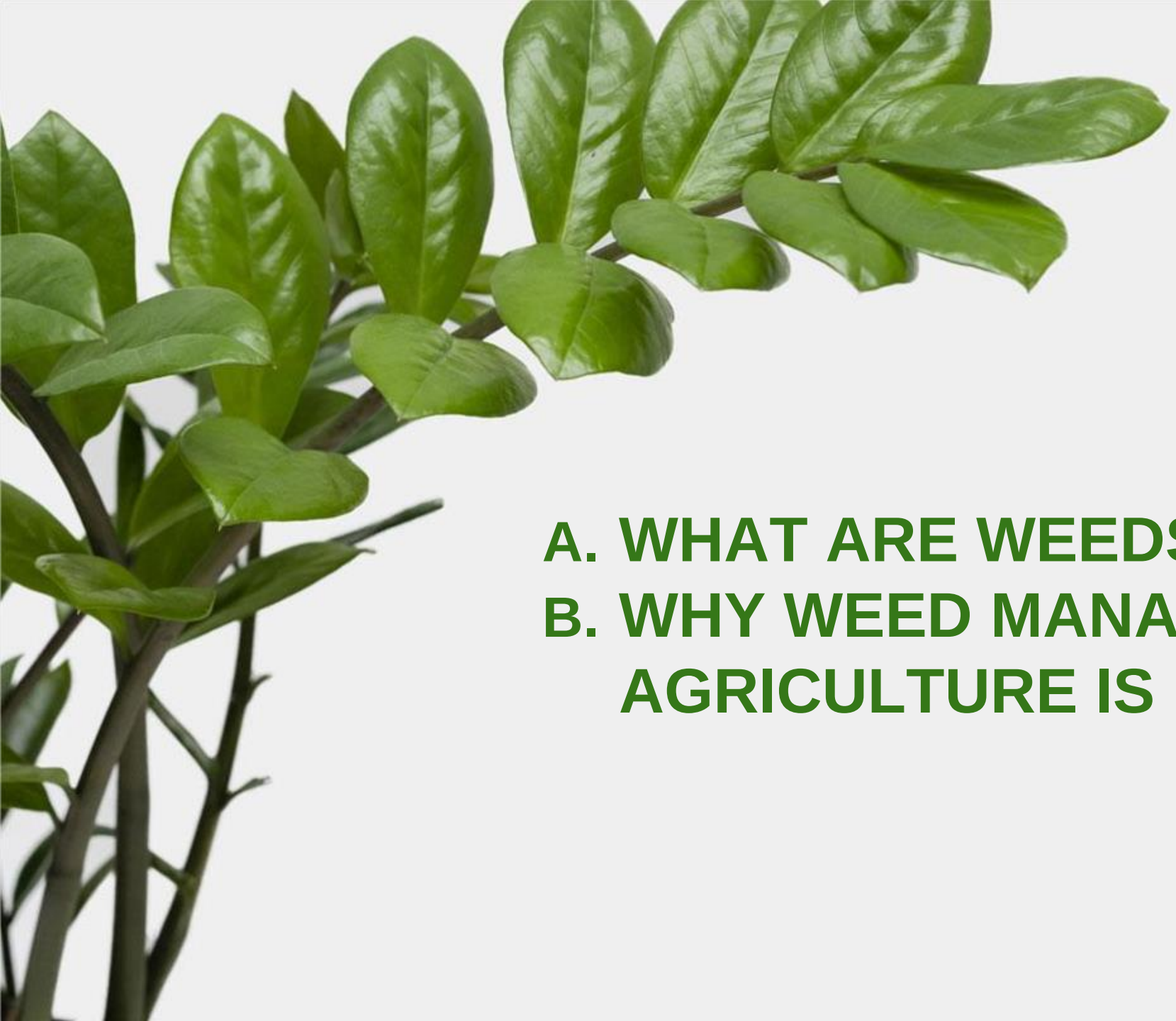


Agriculture is the main stay of India's economy.
Agricultural development is therefore, a precondition of our national prosperity.

CHALLENGES FACED BY AGRICULTURE

- Lack of proper land reform measures
- Lack of credit facilities.
- Lack of fertilizers.
- Lack of proper agriculture research.
- Small and uneconomic holdings.
- Inadequate irrigation facilities.
- Defective marketing facilities.
- Soil erosion.
- Pests and plant diseases.
- Soil erosion.
- Very high dependency on monsoons.

There is a strong link between weed competition and crop yield loss!



A. WHAT ARE WEEDS ?

B. WHY WEED MANAGEMENT IN AGRICULTURE IS IMPORTANT?

WEEDS

Plant grown out of place and not intentionally sown

plant growing where it is not wanted

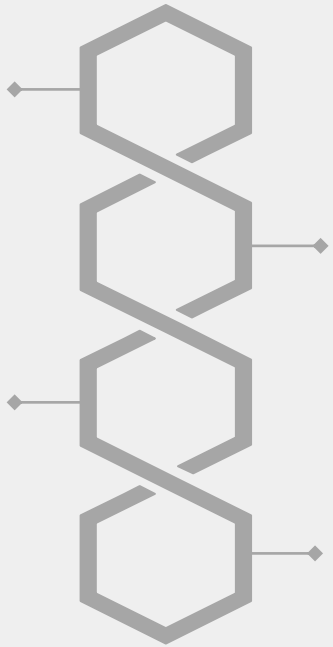
plant whose virtues have not yet been discovered

plants that interfere negatively with human activity

Why is it important to control weed?

Weeds fight with crops in the domain of space soil moisture, nutrients, and solar radiation.

Weeds are the most challenging difficulty of farmers as these threaten their ability to produce good quality food cost-effectively.



Weeds should be removed at every step of the growth of any crop particularly at the initial stages to diminish overall production loss.

Weeds harm crops drop in the commercial value of cultivated areas.

WHY WEED MANAGEMENT IN AGRICULTURE IS DIFFICULT?

Manual Weeding

Hard and labour costing that's why making it infeasible!

Mechanical Weeding

Could not remove intra-row weed and could damage the main crop due to human error!

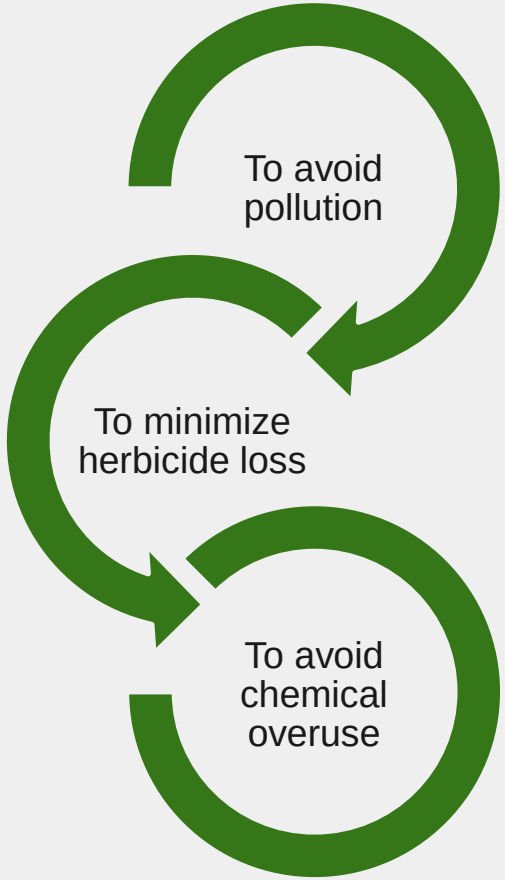
Herbicide Usage

Causes waste of herbicide and environmental pollution!

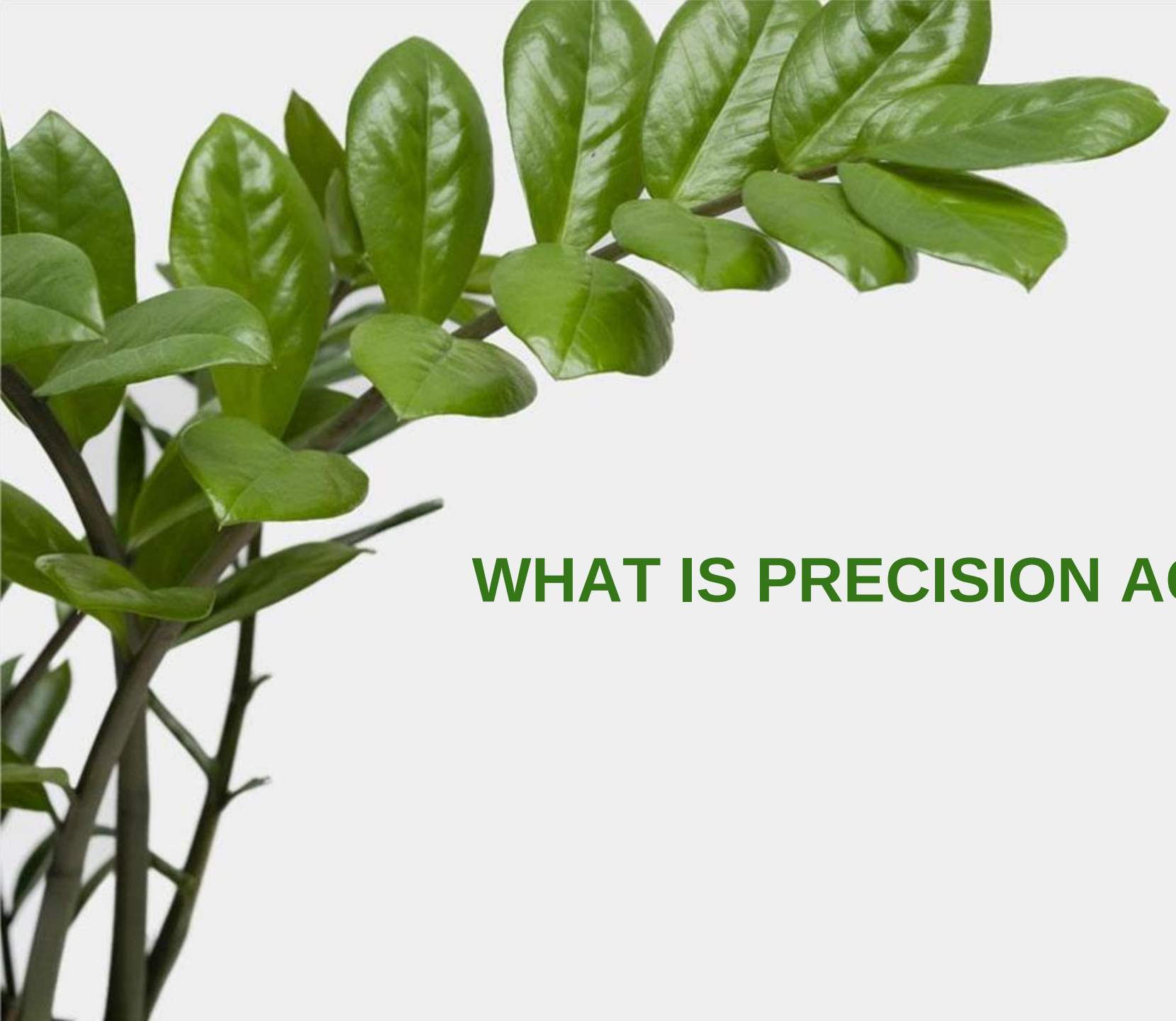
Chemical Weeding

Have detrimental effects on farmer health and undesired environmental pollution!

SOLUTION



Modern technology should be used to autonomously detect weeds and remove it…



WHAT IS PRECISION AGRICULTURE?

Measurement, analysis and appropriate action—both spatial and temporal variability of soil and crop parameters.

objective of optimizing profitability, sustainability and protection of the environment.

PRECISION AGRICULTURE

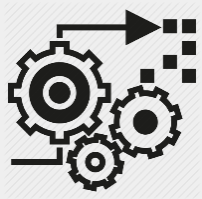
TECHNOLOGY

+

FARMING PROCESSES

OPTIMIZATION
&
DETERMINATION
To reduce production costs and improve the quality of crops.

HOW IS PRECISION AGRICULTURE USED IN WEED MANAGEMENT?



approaches

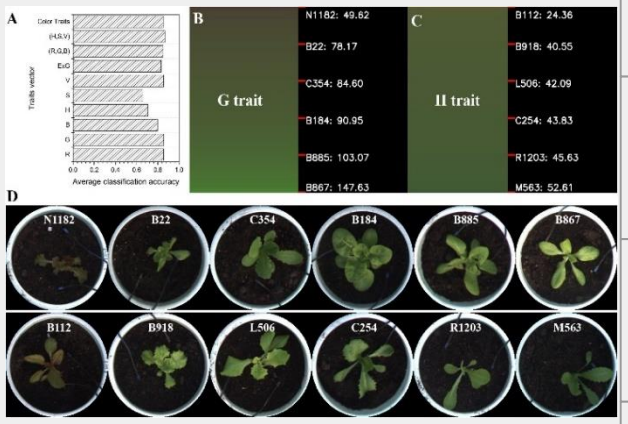
Colour Based classification

Threshold-based classification

Learning-based classification

Support vector machine

Deep learning



Weed Detection by Computational Vision!

Vision System Flow Chart

Image acquisition

Green component image subtract

Median filtering

Thresholding

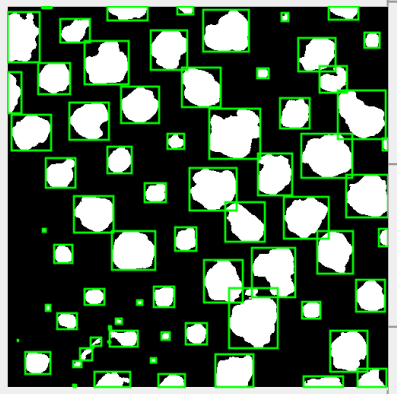
Segmentation

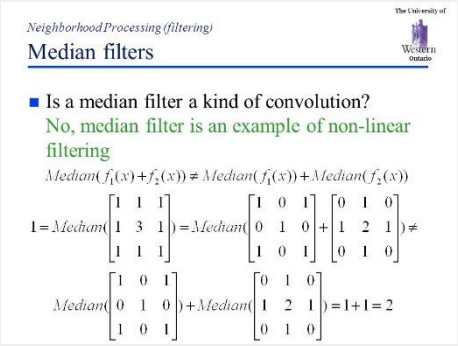
Remove small objects

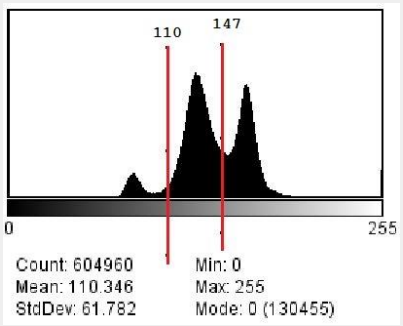
Objects Labeling

Extract area feature

Weed detection based on area







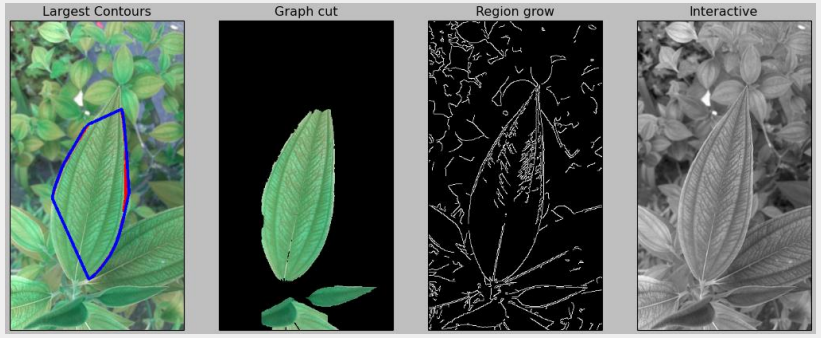
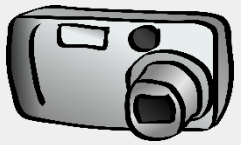


Image acquisition

- perspective projection over crop
- avoid lighting and sharpness problems
- color changes about vegetation are reduced



Input image

Green plant detection algorithm

- Ways of separating separation from the soil
- Different sunlight and background conditions

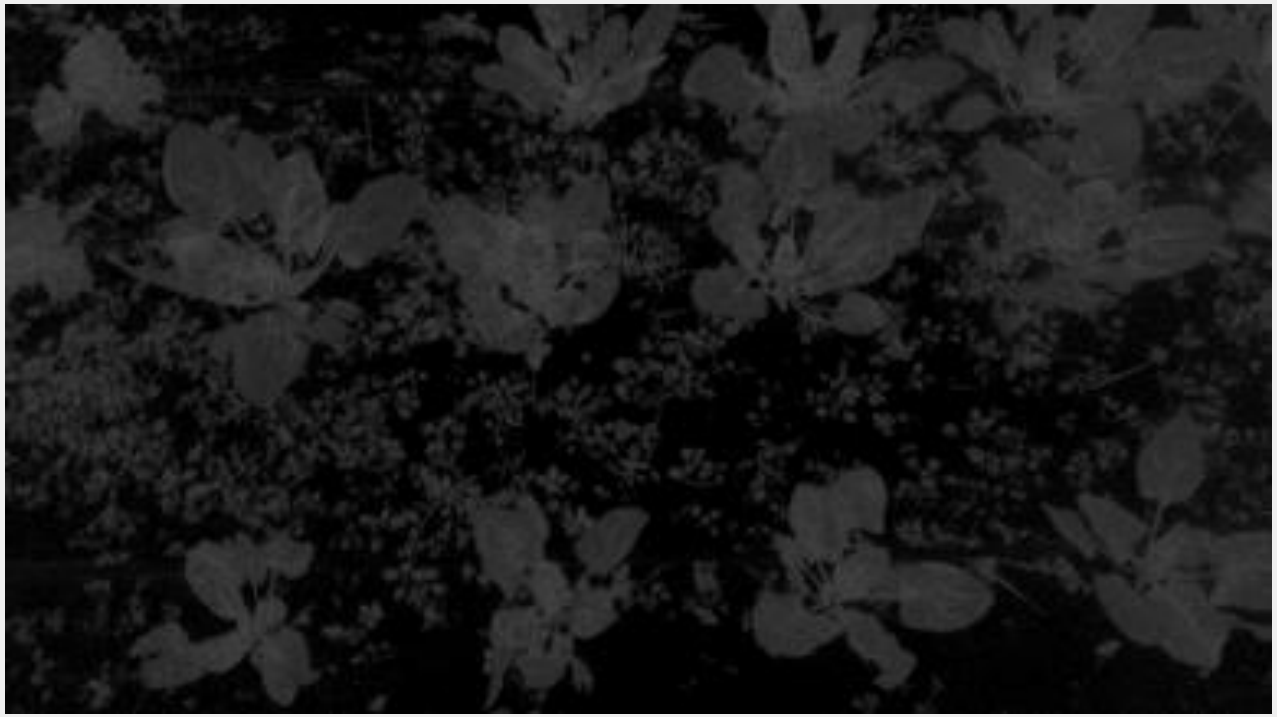
I. Source image is converted to grayscale intensity whereby the hue and saturation information is eliminated while retaining the luminance
II. All components in XY space corresponding to green value on image are subtracted from the corresponding element in grayscale array

Image subtracted

$$I_{plant}(x_{pixel},y_{pixel})=I_{green\_source}(x_{pixel},y_{pixel},G)-I_{gray}(x_{pixel},y_{pixel})$$

Median filtering

- noise suppression
- pixel values around 3-by-3 neighborhood mask
- preserving edges whereby the relevant image information is conserved and tends to produce regions of constant or nearly constant intensity



Median filtering

Feature Extraction

- segment the image in order to locate plants
- assigning a label to each pixel
- highlighting the similarity of the features used for detection of plants
- color and area serves as descriptors for a threshold classifier

Segmentation is accomplished by

$$I_{bin}(x,y) = \begin{cases} 0, I_{Median}(x,y) < t \\ 1, I_{Median}(x,y) \geq t \end{cases}$$

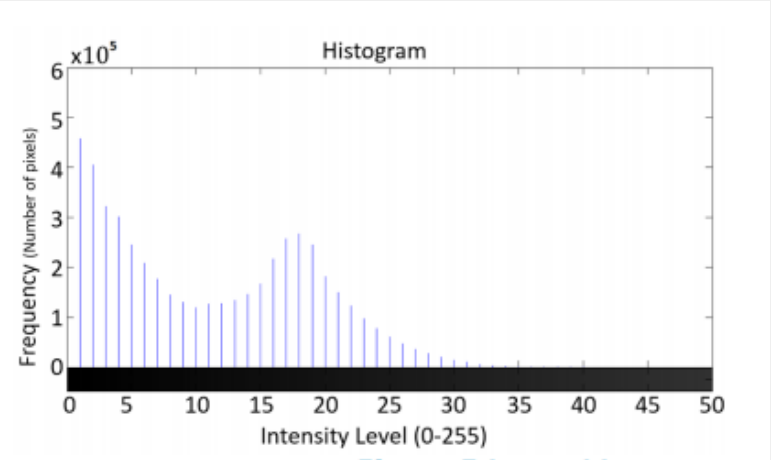


Image Histogram

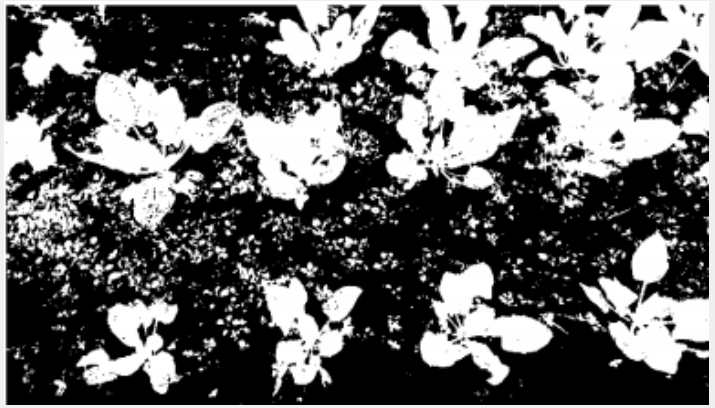
➢ Otsu method

Estimates optimal threshold to segment through an exhaustive search of maximum variance between classes in gray levels

Fill image holes

- Morphological reconstruction
- This method uses 4 or 8 connected neighborhood pixels to evaluate the resulting image

$$F_{mark}(x,y) = \begin{cases} 1 - I_{source}(x,y), & (x,y \text{ is on the border of } I_{source}) \\ 0, & \text{otherwise} \end{cases}$$



Threshold segmentation

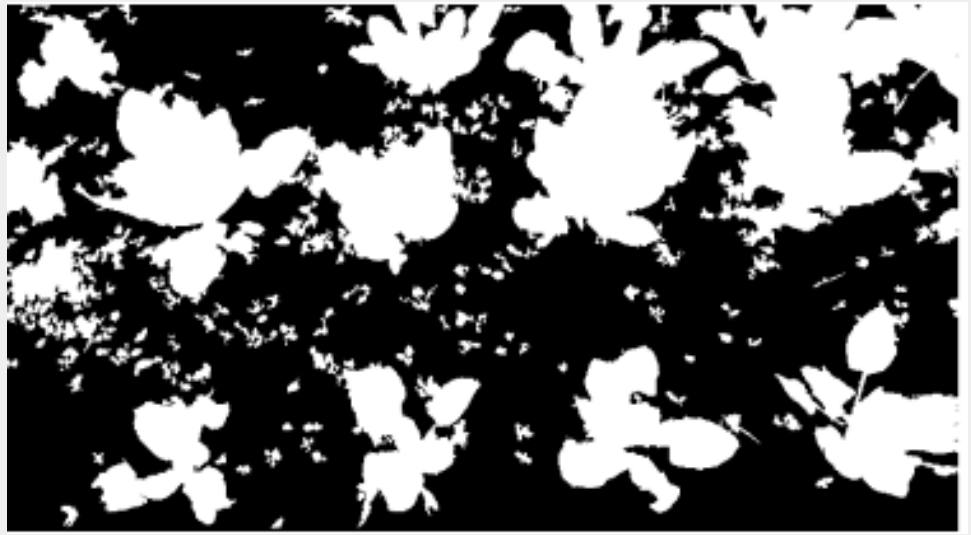
Fill image holes

- Iterates until it reaches all image positions,

$$H_k = (H_{k-1} \otimes B) \cap G$$

where B is a 3 x 3 matrix of ones,
H0 =F_{mark}
G image to fill in the holes.

- Then, H_k , is a binary image with holes filled in.



Images with holes filled

Labelling

- Identifying objects in the scene, requires to label each element as a plant, getting a region description in order to extract features in the next step.
- Therefore, an algorithm based on connected components is used.
- The region labeling stage evaluates each pixel with a 4 neighbor-connectivity.

Classification based on area

- Extract area features from each element to discriminate weed and crop
- The algorithm presented, defines an area counting the number of pixels in the object region then, the value is stored for all items.

Weeds detected

ANALYSIS

- The classes assigned to define the specificity and sensitivity are shown as follows:

• True positive (TP): Number of plants detected as weed correctly.
• True negative (TN): Number of plants detected as crop correctly.
• False positive (FP): Number of crop plants detected as weed.
• False negative (FN): Number of weed plants detected as crop.

- Each image is accompanied with a table that indicates sensitivity and specificity to group information about correct weed detection. Additionally, positive and negative values are calculated to highlight the percentage of true positive and true negative detections with respect to all classifications.

  The indices are calculated as follows:

  • Sensitivity = TP/(TP+FN)
  • Specificity = TN/(FP+TN)
  • Positive predictive value (PPV) = TP/(TP+FP)
  • Negative predictive value (NPV) = TN/(FN+TN)

Weeds plant detected

	Weed Plants (Confirmed manually)		
	Condition Positive	Condition Negative	
Plants detected as Weed	True Positive (TP)	False Positive (FP)	PPV
	80	1	0.98
Plants detected as crop	False Negative (FN)	True Negative (TN)	NPV
	5	6	0.545
	Sensitivity	Specificity	
	0.94	0.857	

Results : Algorithm of Weed Detection in Crops by Computational Vision

Conclusion and Future Work

1. High performance and accuracy validated with sensitivity and specificity indices above 90%
2. Most of plants detected as weed are true positive
3. Reduce the cost per hour of work required for inspecting weeds in crops

- Use crop rows to estimate a grid, in which weed detection includes plants position
- Due to random behavior of weeds and include shape features to complement classification stage

Weeds plant detected

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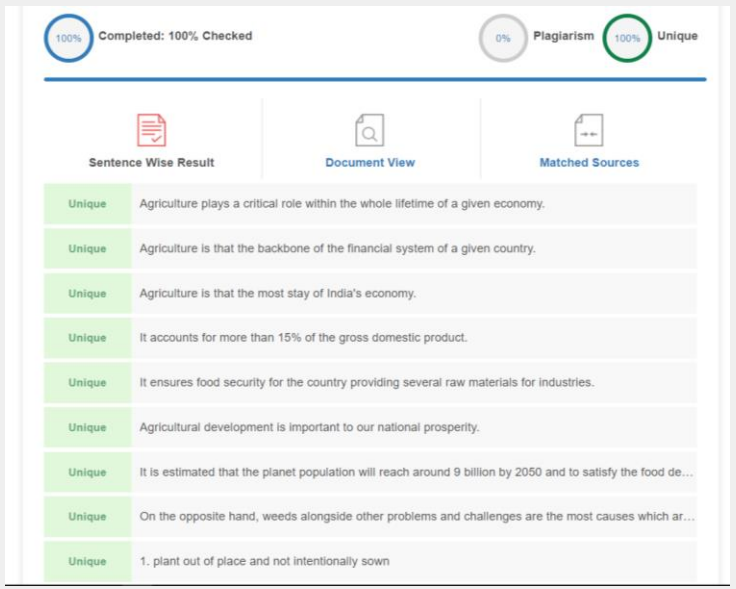
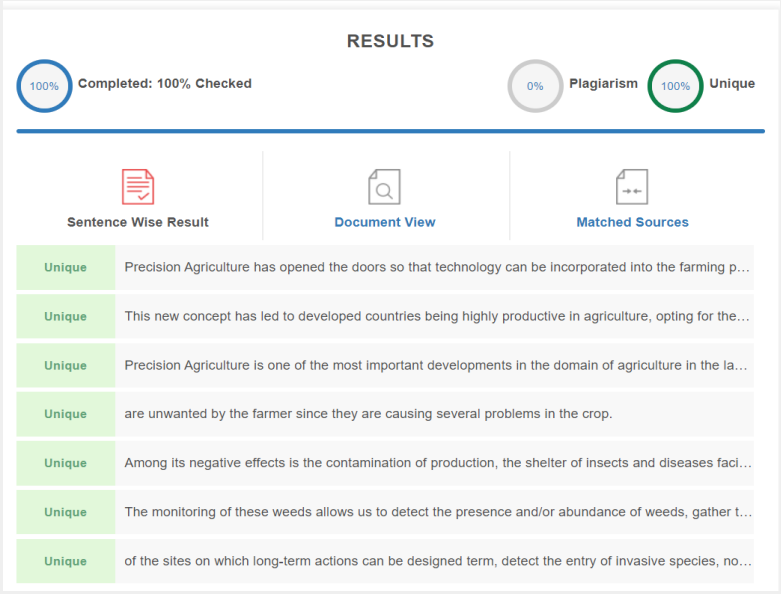
4. S. I. Moazzam, U. S. Khan, M. I. Tiwana, J. Iqbal, W. S. Qureshi and S. I. Shah, "A Review of Application of Deep Learning for Weeds and Crops Classification in Agriculture," 2019 International Conference on Robotics and Automation in Industry (ICRAI), 2019, pp. 1-6, doi: 10.1109/ICRAI47710.2019.8967350.
5. F. Miao, S. Zheng and B. Tao, "Crop Weed Identification System Based on Convolutional Neural Network," 2019 IEEE 2nd International Conference on Electronic Information and Communication Technology (ICEICT), 2019, pp. 595-598, doi: 10.1109/ICEICT.2019.8846268.

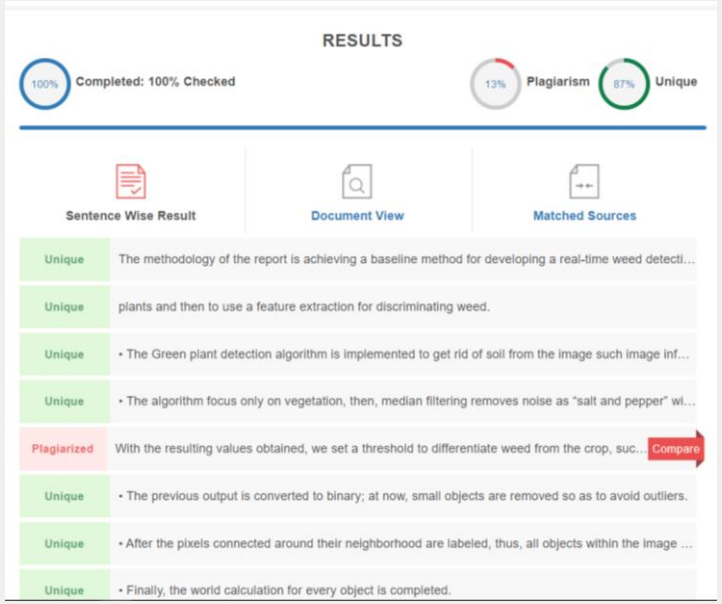
IMAGES

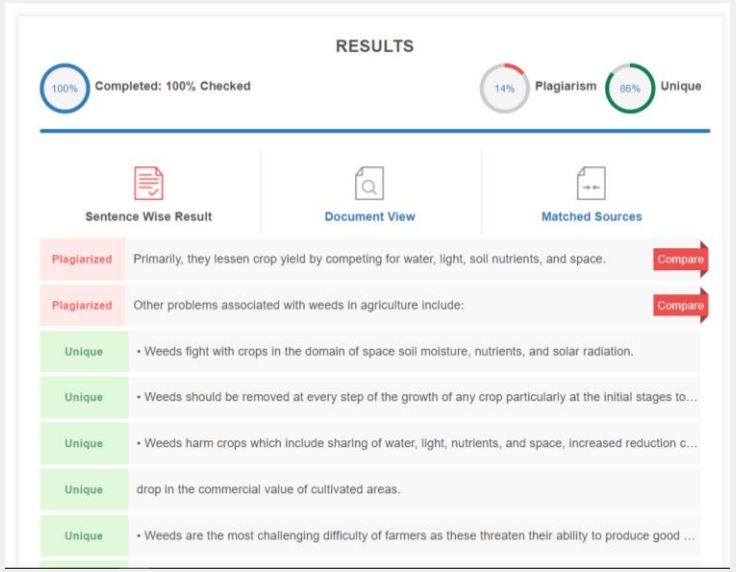
1. Bing Images
2. Google Images

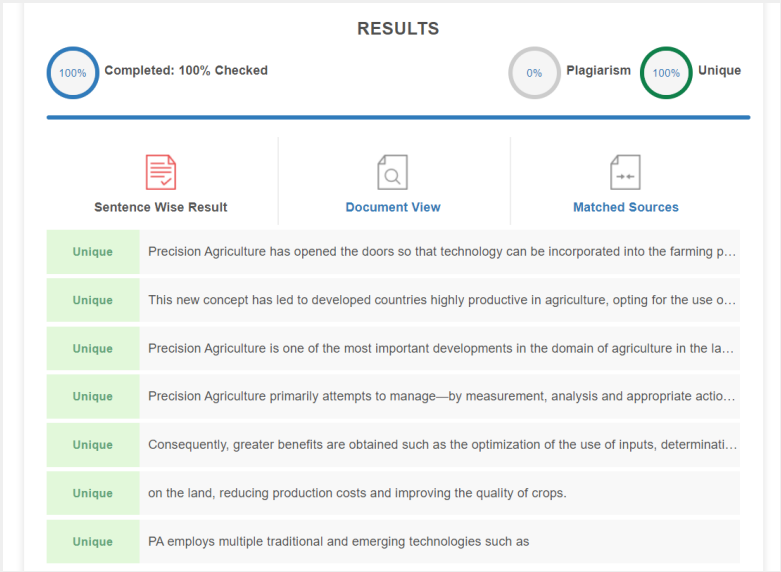
Plagiarism report

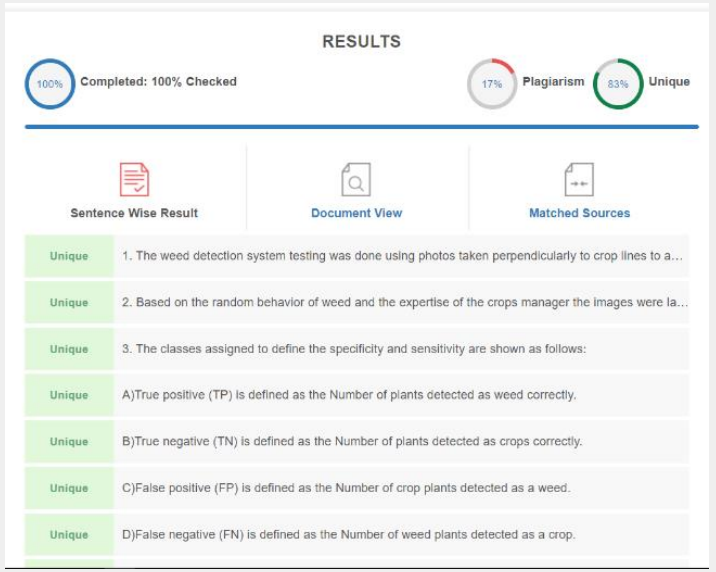












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