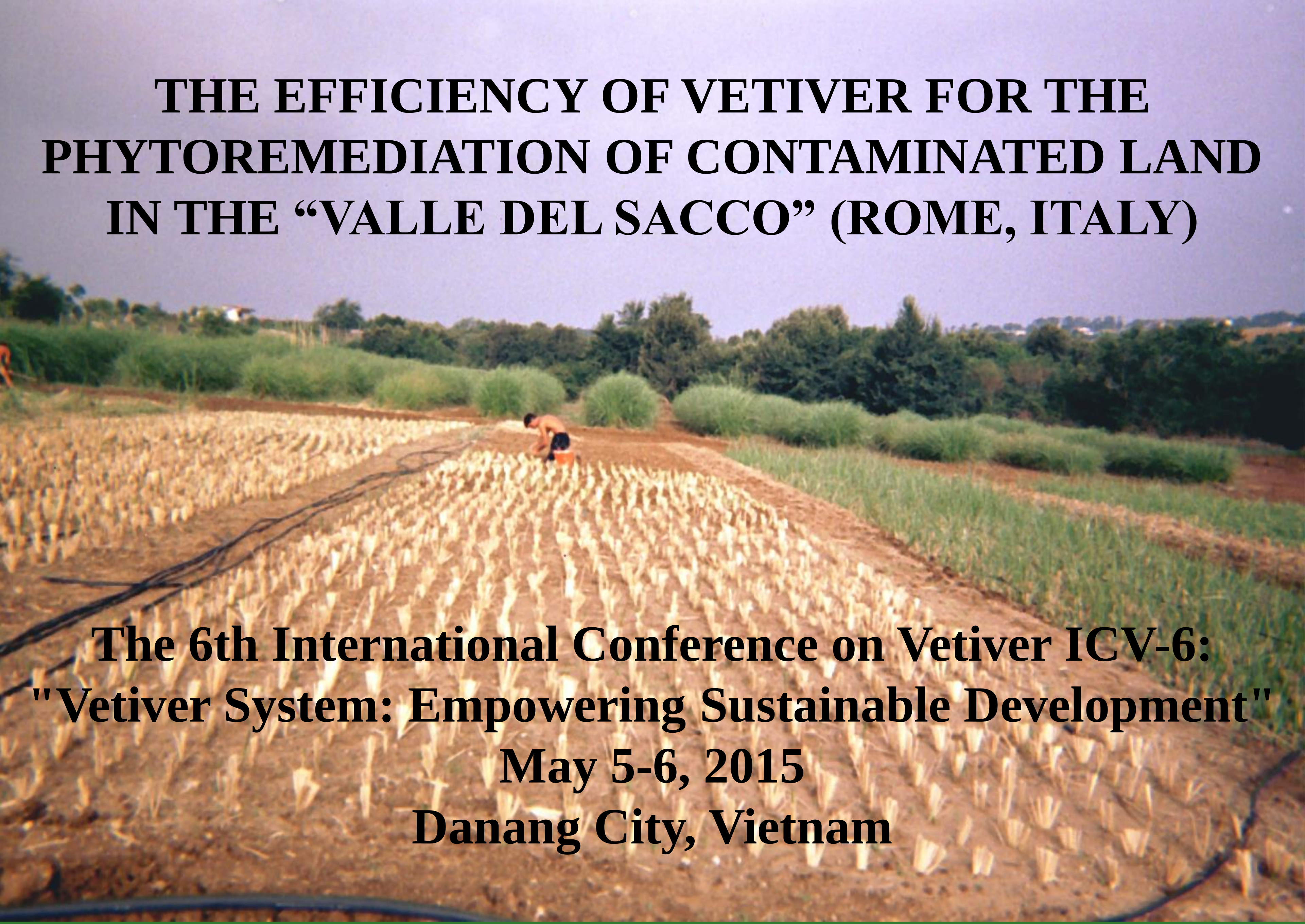
THE EFFICIENCY OF VETIVER FOR THE PHYTOREMEDIATION OF CONTAMINATED LAND IN THE “VALLE DEL SACCO” (ROME, ITALY)



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RESEARCH PROJECT

TERRITORY UNDER STUDY:

“Valle del Sacco” (Sacco River Valley), near Rome:

It includes 22 towns situated along the Sacco River banks and their hinterland.

Natural soil environment has been altered by agricultural chemicals and improper disposal of industrial waste.

Diseases and deformities in people, animals and plants have been caused by soil pollution .

PARTICIPANTS IN THE PROJECT

"Sapienza" University of Rome
(Dept. Chemical Engineering, Materials and Environment)

ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development)

The author, a professional in the field of environmental reclamation, vetiver producer and a consultant of ENEA

BACKGROUND TO THE PROJECT

University's intention: to use Canola to treat the contaminated land

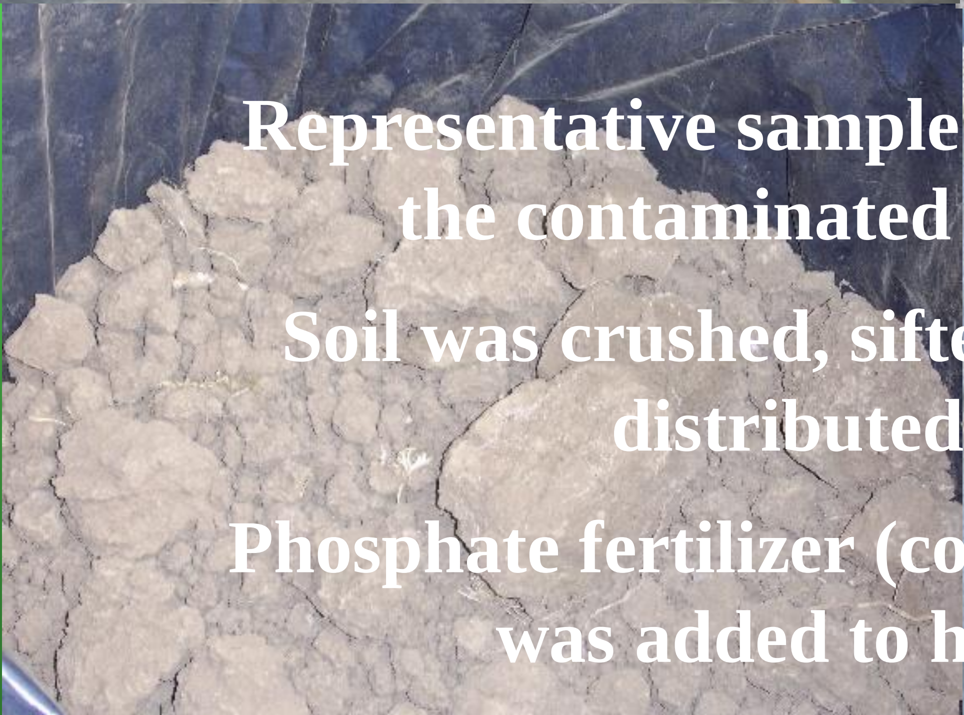
Author's proposal: to use Vetiver to remove pollutants in the soil and involve ENEA's UTAGRI Unit

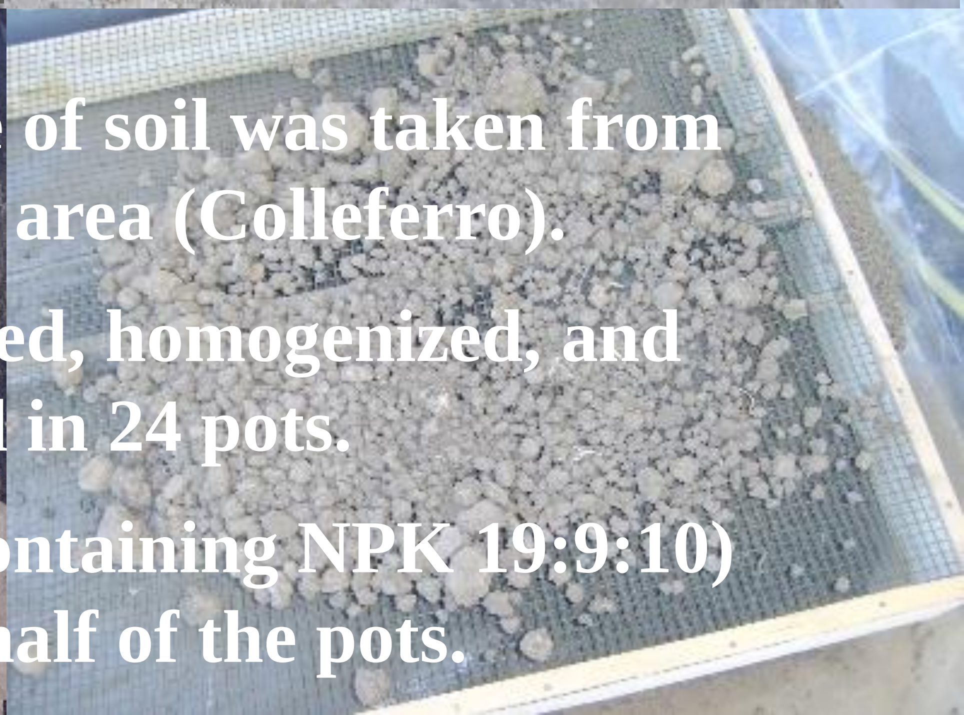
Final objective: to assess the phytoremediation potential of both Canola (*Brassica Napus*, L.) and Vetiver (*Vetiveria Zizanioides*, L.) in soils contaminated by toxic elements

Type of experiment: growing the plants in a laboratory, in collaboration with ENEA

MATERIALS AND METHODS

First Phase: Preparation of Soil, Irrigation Water, Pots and Planting





Representative sample of soil was taken from the contaminated area (Colleferro).

Soil was crushed, sifted, homogenized, and distributed in 24 pots.

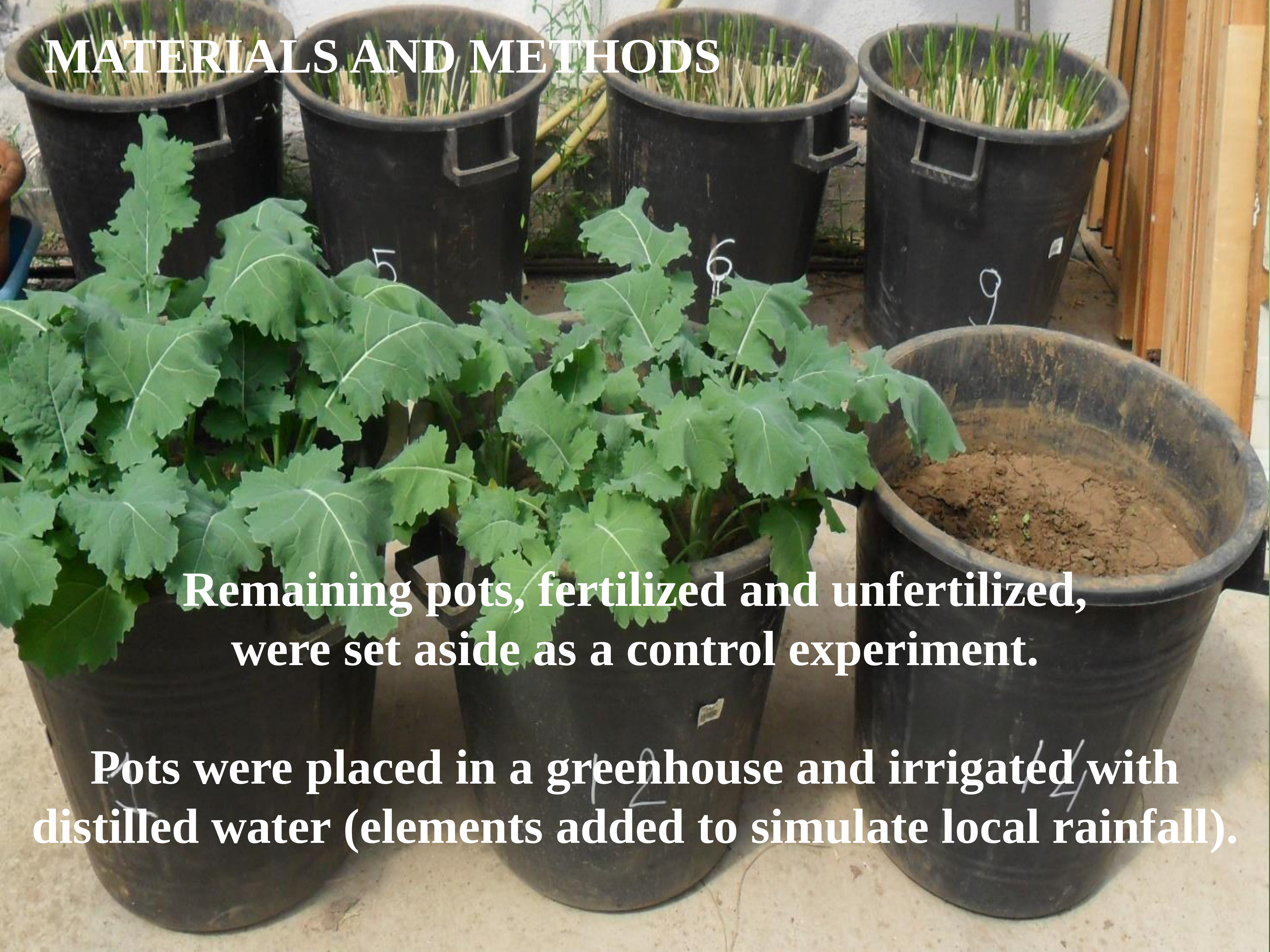
Phosphate fertilizer (containing NPK 19:9:10) was added to half of the pots.

MATERIALS AND METHODS

15 tillers of vetiver were planted in each of ten pots, five fertilized and five unfertilized.

15 seeds of canola were sown in each of ten pots, half fertilized and half unfertilized.

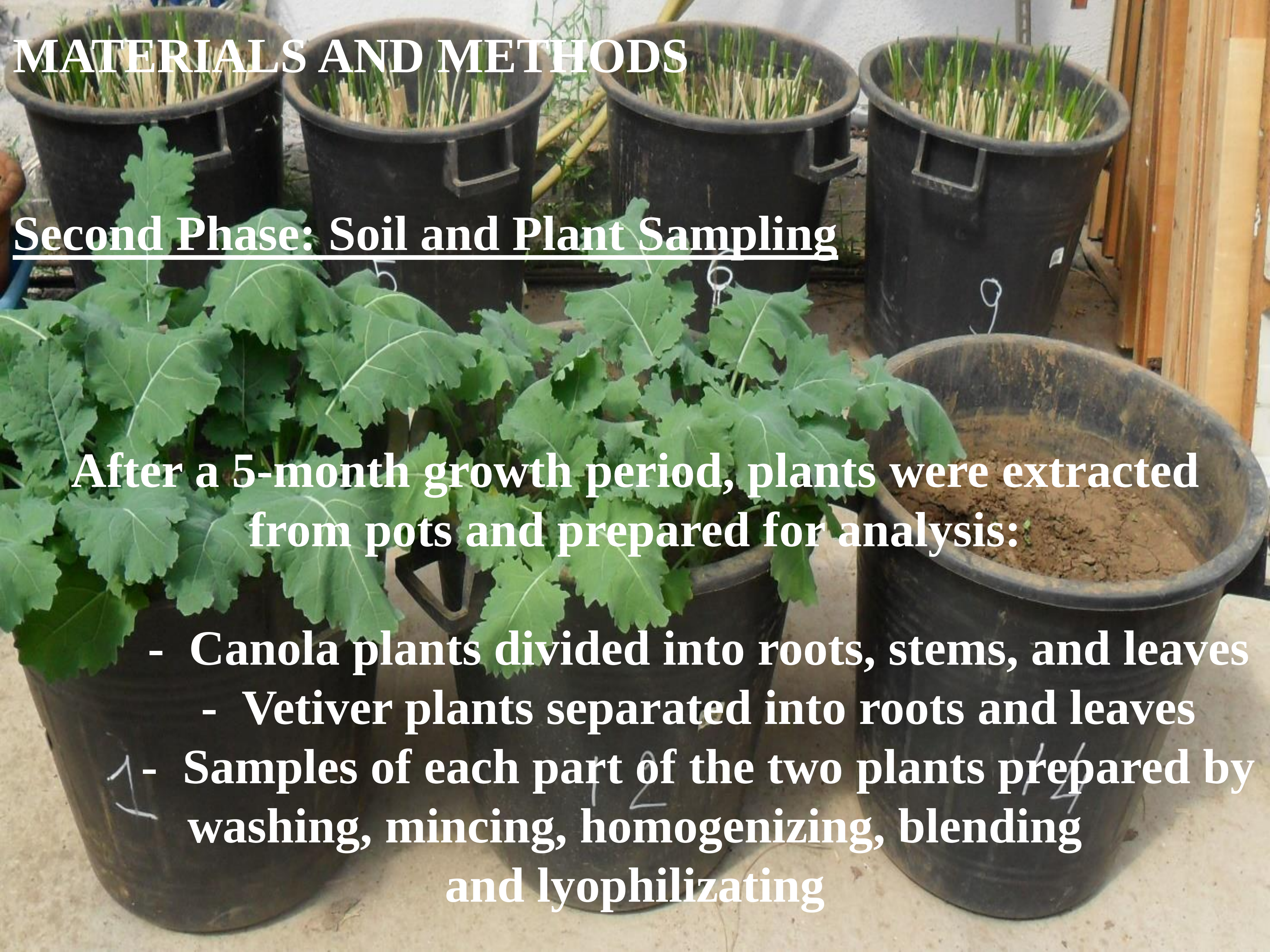
MATERIALS AND METHODS



Remaining pots, fertilized and unfertilized, were set aside as a control experiment.

Pots were placed in a greenhouse and irrigated with distilled water (elements added to simulate local rainfall).

MATERIALS AND METHODS

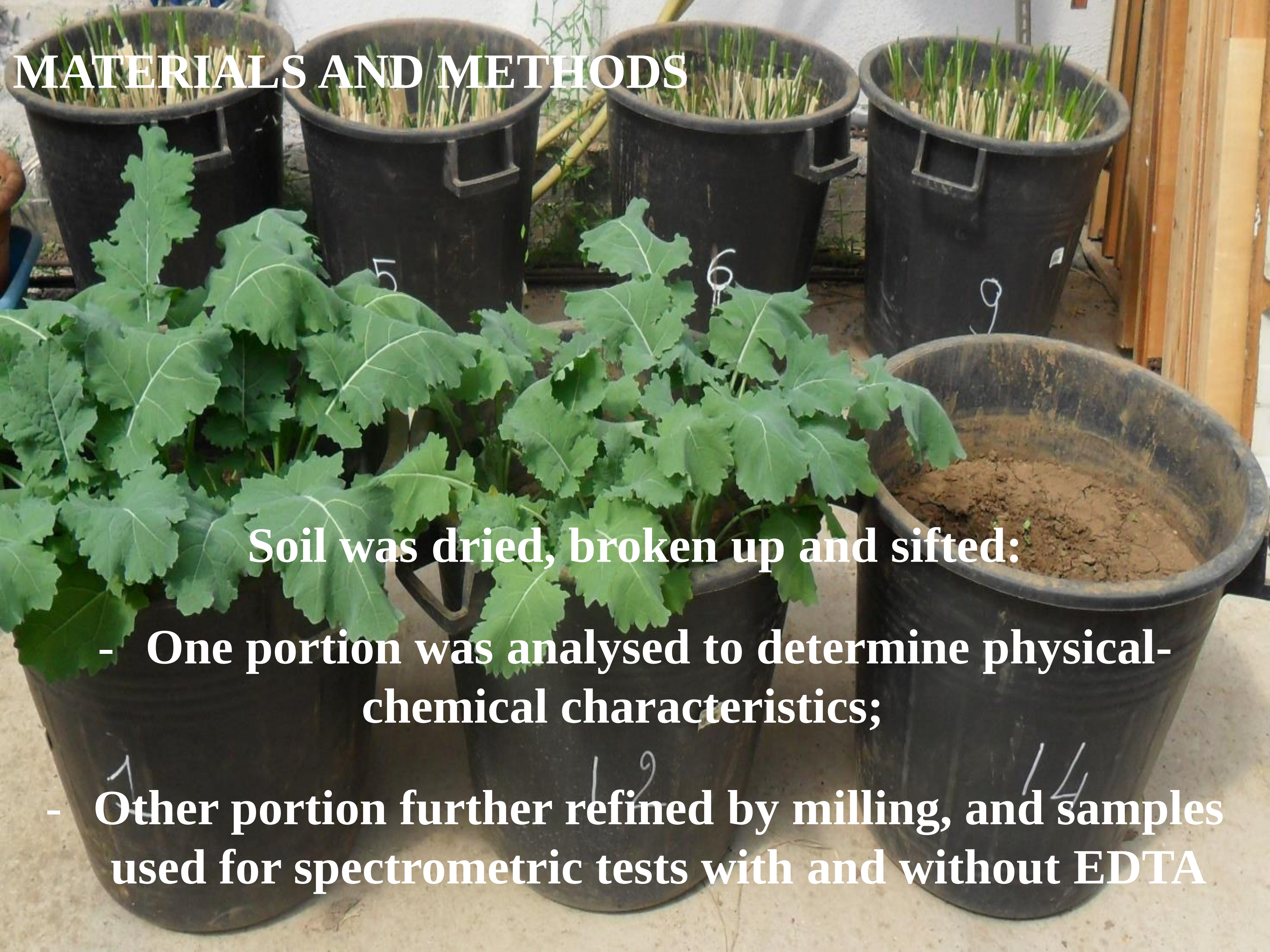


Second Phase: Soil and Plant Sampling

After a 5-month growth period, plants were extracted from pots and prepared for analysis:

- **Canola plants divided into roots, stems, and leaves**
- **Vetiver plants separated into roots and leaves**
- **Samples of each part of the two plants prepared by washing, mincing, homogenizing, blending and lyophilizating**

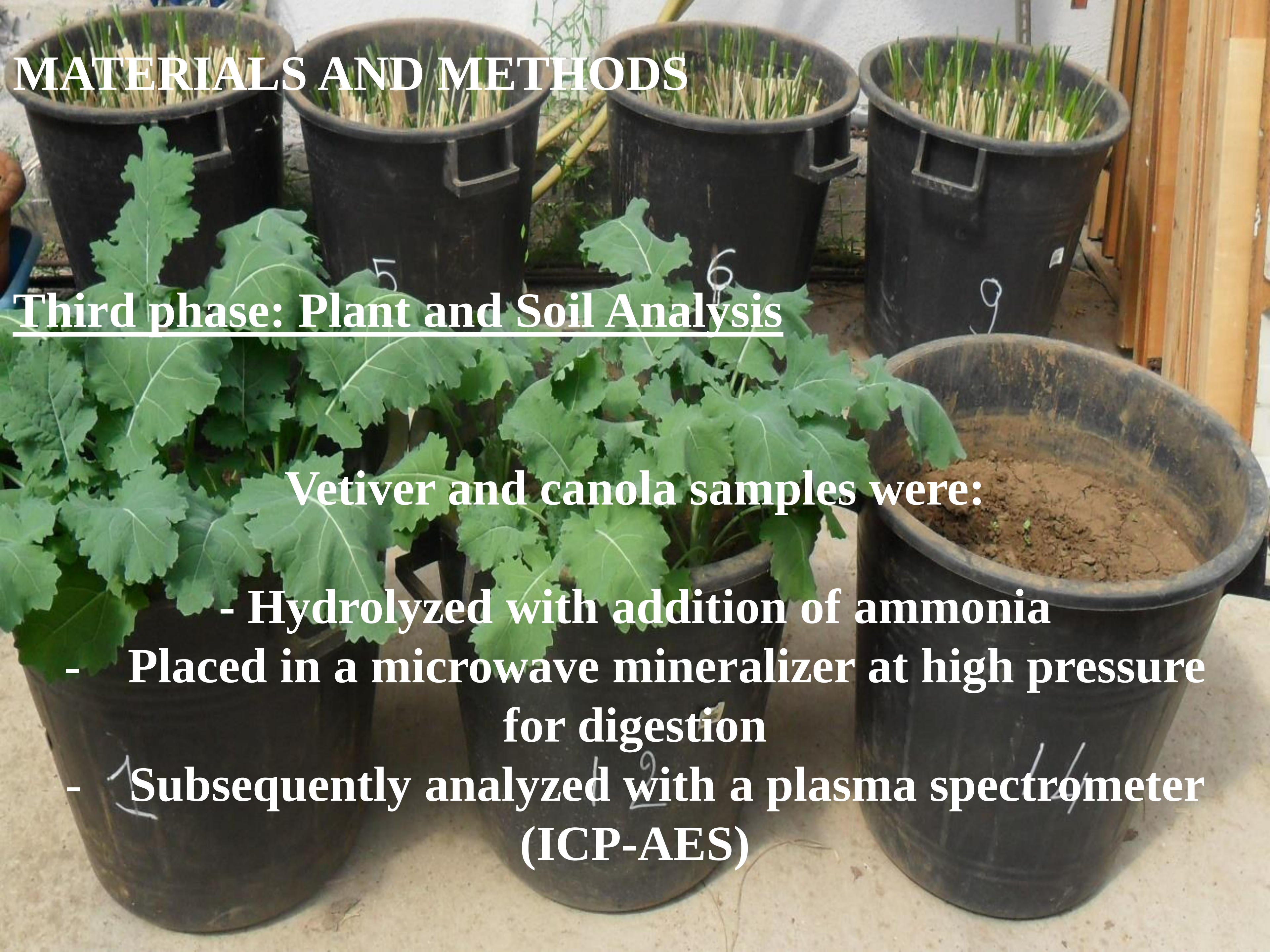
MATERIALS AND METHODS



Soil was dried, broken up and sifted:

- **One portion was analysed to determine physical-chemical characteristics;**

- **Other portion further refined by milling, and samples used for spectrometric tests with and without EDTA**

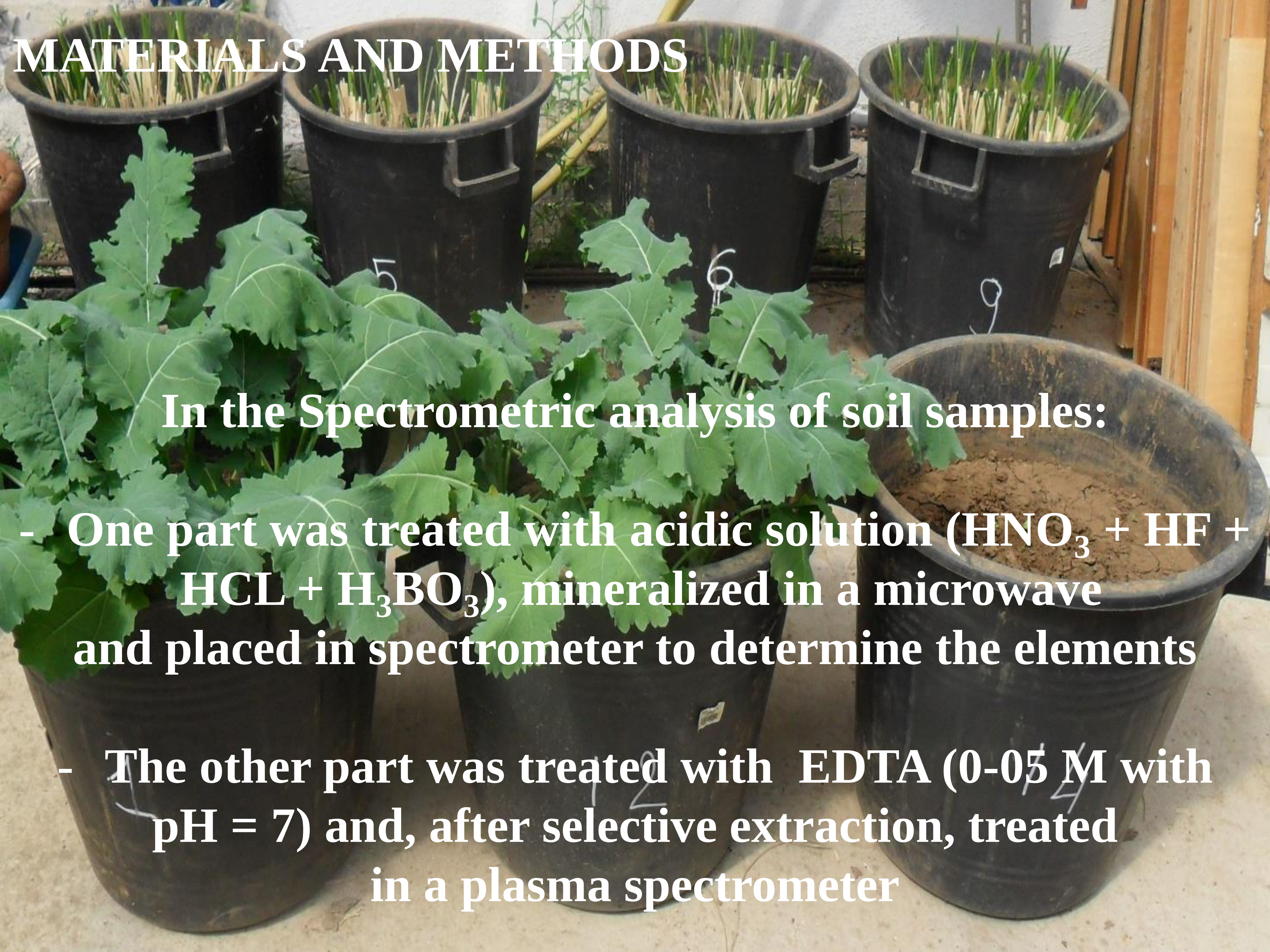


MATERIALS AND METHODS

Third phase: Plant and Soil Analysis

Vetiver and canola samples were:

- **Hydrolyzed with addition of ammonia**
- **Placed in a microwave mineralizer at high pressure for digestion**
- **Subsequently analyzed with a plasma spectrometer (ICP-AES)**



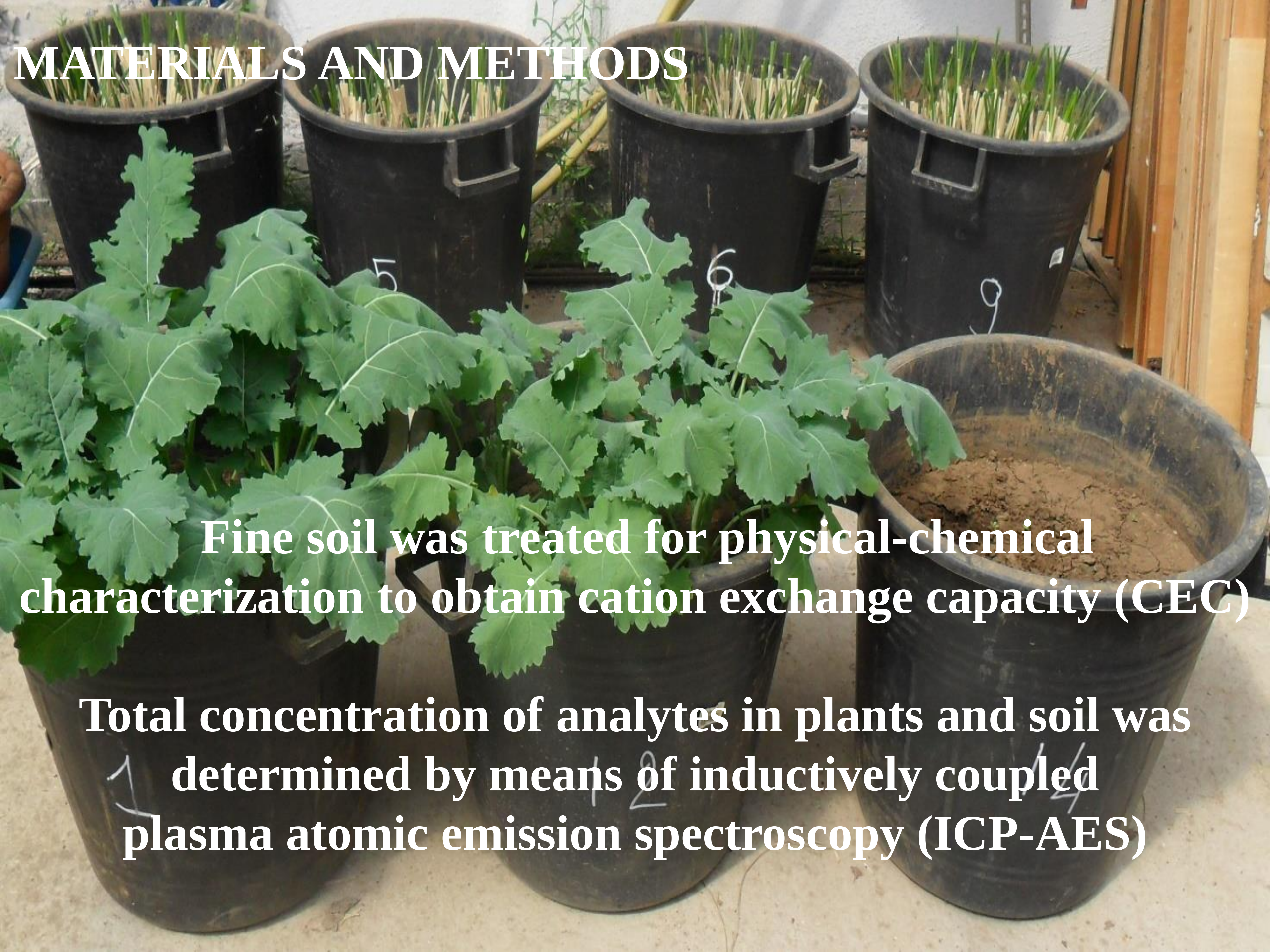
MATERIALS AND METHODS

In the Spectrometric analysis of soil samples:

- **One part was treated with acidic solution (HNO_3 + HF + HCL + H_3BO_3), mineralized in a microwave and placed in spectrometer to determine the elements**

- **The other part was treated with EDTA (0-05 M with pH = 7) and, after selective extraction, treated in a plasma spectrometer**

MATERIALS AND METHODS



Fine soil was treated for physical-chemical characterization to obtain cation exchange capacity (CEC)

Total concentration of analytes in plants and soil was determined by means of inductively coupled plasma atomic emission spectroscopy (ICP-AES)

MATERIALS AND METHODS

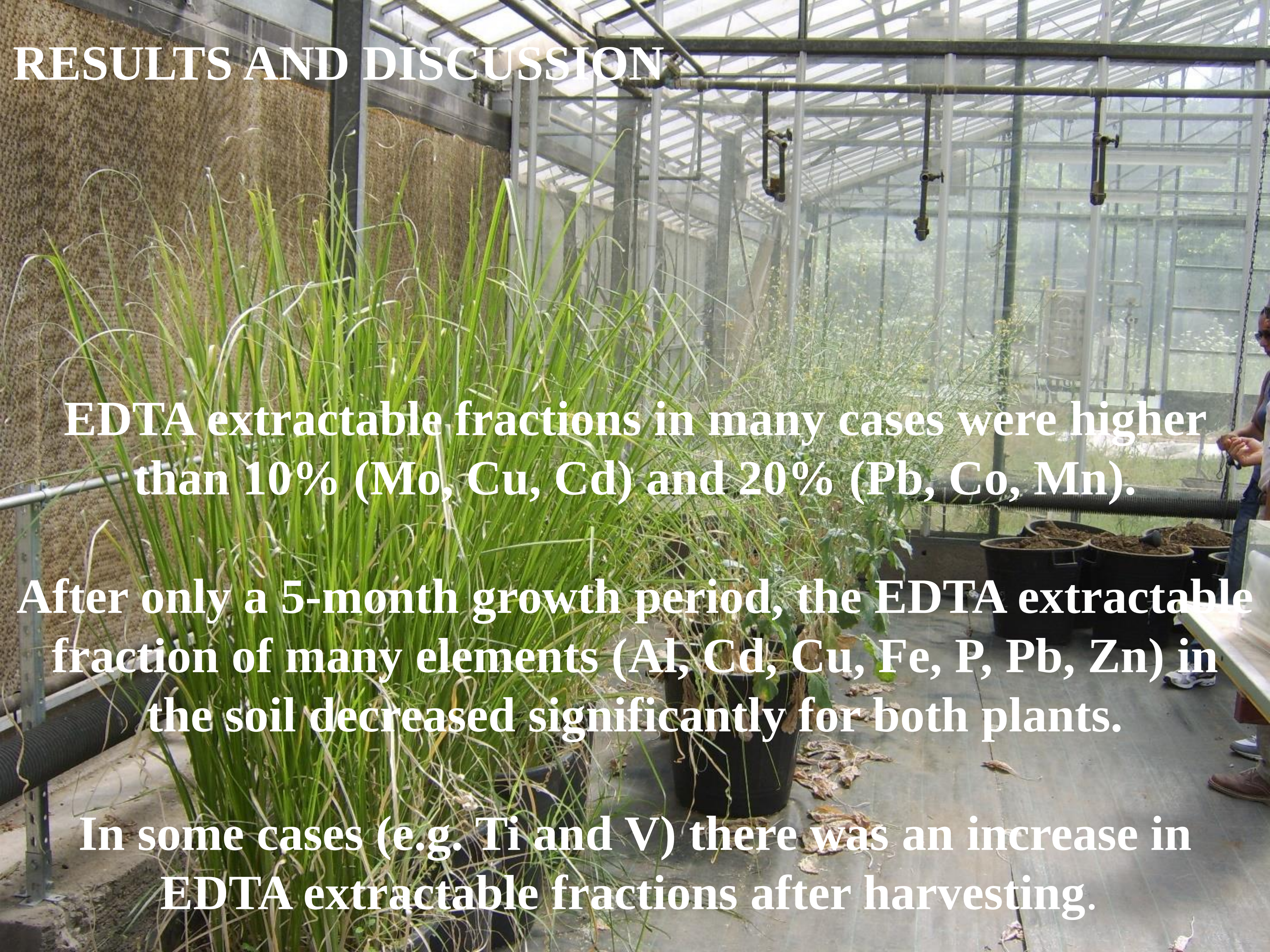
The Aims of the Procedures:

1) to determine the total input of toxic elements: from the soil, irrigation water (simulated rainwater) and added fertilizer, before and after plant growth

2) to determine the toxic element contents in different plant tissues separately

3) to obtain information about the mobile fractions of toxic elements in the soil

RESULTS AND DISCUSSION



EDTA extractable fractions in many cases were higher than 10% (Mo, Cu, Cd) and 20% (Pb, Co, Mn).

After only a 5-month growth period, the EDTA extractable fraction of many elements (Al, Cd, Cu, Fe, P, Pb, Zn) in the soil decreased significantly for both plants.

In some cases (e.g. Ti and V) there was an increase in EDTA extractable fractions after harvesting.

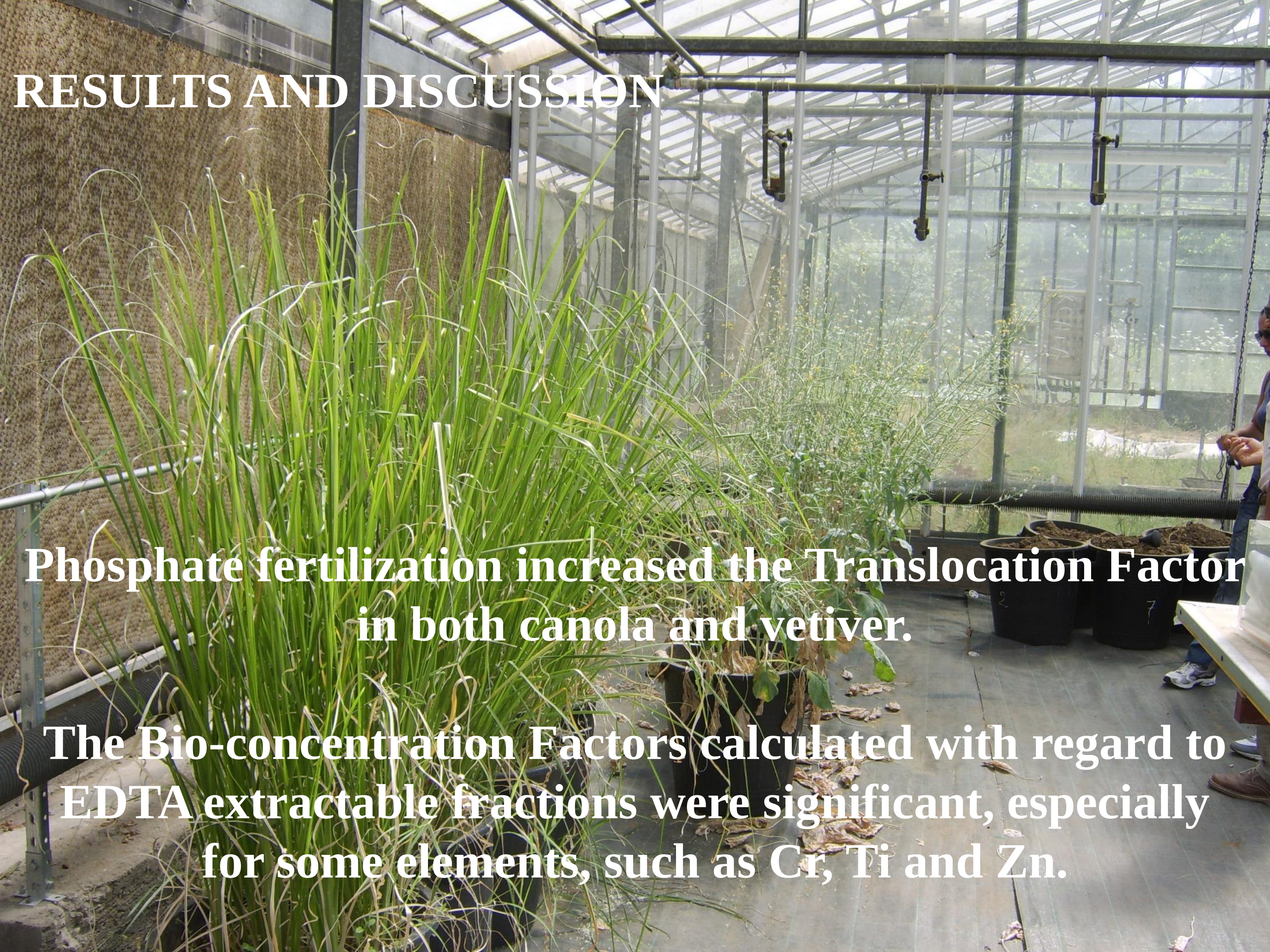
RESULTS AND DISCUSSION

Soil Electrical Conductivity was much reduced after harvesting as a result of the effect of both plants, for vetiver by as much as 50%.

For many elements, vetiver showed a higher Bio-concentration Factor than canola, and the Translocation Factor was generally lower.

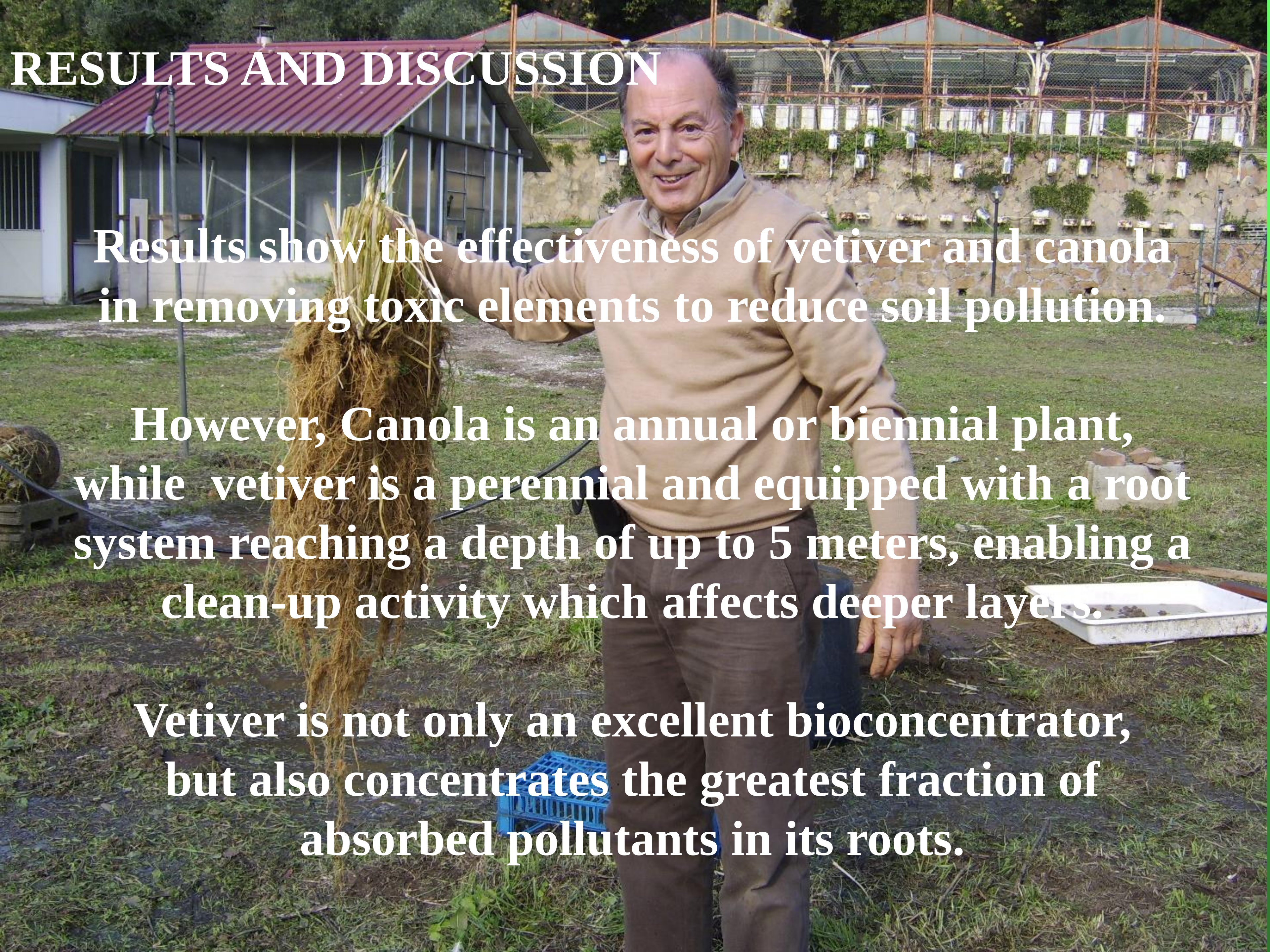
For vetiver, the greatest fraction of absorbed pollutants was in its roots.

RESULTS AND DISCUSSION



Phosphate fertilization increased the Translocation Factor in both canola and vetiver.

The Bio-concentration Factors calculated with regard to EDTA extractable fractions were significant, especially for some elements, such as Cr, Ti and Zn.



RESULTS AND DISCUSSION

Results show the effectiveness of vetiver and canola in removing toxic elements to reduce soil pollution.

However, Canola is an annual or biennial plant, while vetiver is a perennial and equipped with a root system reaching a depth of up to 5 meters, enabling a clean-up activity which affects deeper layers.

Vetiver is not only an excellent bioconcentrator, but also concentrates the greatest fraction of absorbed pollutants in its roots.

CONCLUSIONS

Plants are potential biotechnological tools that can be used massively to re-establish environmental equilibrium.

Vetiver is not only strong enough to remove toxic elements from polluted sites, but also adapted well to the contaminated soil of Valle del Sacco.

In the research reported here, the data did not reveal a level of pollution to account for the environmental disaster taking place in the Valle del Sacco, so vetiver could not realize its full potential.

CONCLUSIONS

The research is being continued, growing plants in a field experiment in another area of Valle del Sacco (Anagni), where both vetiver and canola have been planted.

Canola has not succeded in covering the entire area, possibly because of the higher level of soil pollution.

CONCLUSIONS

So far vetiver has grown very well.

These results with the new analysis of the elements will be presented in another paper.

FINAL CONSIDERATIONS

Vetiver biomass can be used to produce pellet, energy and syngas to reduce the cost of phytoremediation.

FINAL CONSIDERATIONS

The author is in the process of finalizing a proposal, involving a pilot project over an area of 12 hectares to be planted with vetiver. This project would result in a further reduction of costs thanks to the profits derived from the use of vetiver biomass.

FINAL CONSIDERATIONS

Vetiver biomass used in a fluid bed reactor of the type already experimented with in Italy would produce for each kg of vetiver more than two cubic meters of syngas, 60% of which is hydrogen.

This gas can be used on site for the production of electricity with fuel cells, using vetiver as a permanent reservoir of biomass which produces energy by reducing CO_2.

FINAL CONSIDERATIONS

A video clip from Italian State Television (RAI) regarding the production of energy with vetiver biomass is available for viewing here at the conference

THANK YOU !

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