Utilization and Management of Mycorrhiza to Support Land Productivity: The Philippines' Experience

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BIOTECH

Order of presentations

I. What is mycorrhiza?
II. Mycorrhizal technologies
III. Utilization for enhanced land productivity

MYCORRHIZA

"mykes" ⟷ ***"rhizaa"***

Highly interdependent mutualistic relationship

(fungus) **(roots)**

Benefits

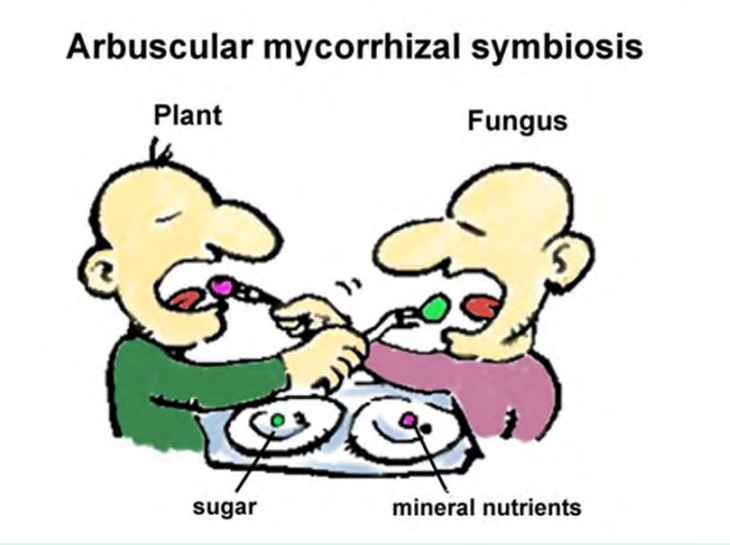
- Obtains photosynthetically derived carbon compounds **=carbohydrates as food**
- Host to complete life cycle- **spore-hyphae-spore**

- Receives more mineral nutrients and water
- Has root extenders, since fungal hyphae are thinner, spread wider and deeper into the soil

Facts about Mycorrhiza

- ☺ ubiquitous (found everywhere)
- ☺ normal plant status is mycorrhizal
- ☺ abnormal = non- mycorrhizal

☺ mycorrhizal effects are best observed if plants are grown under stressed conditions: infertile soil, low moisture, presence of heavy metals too acidic or basic soil



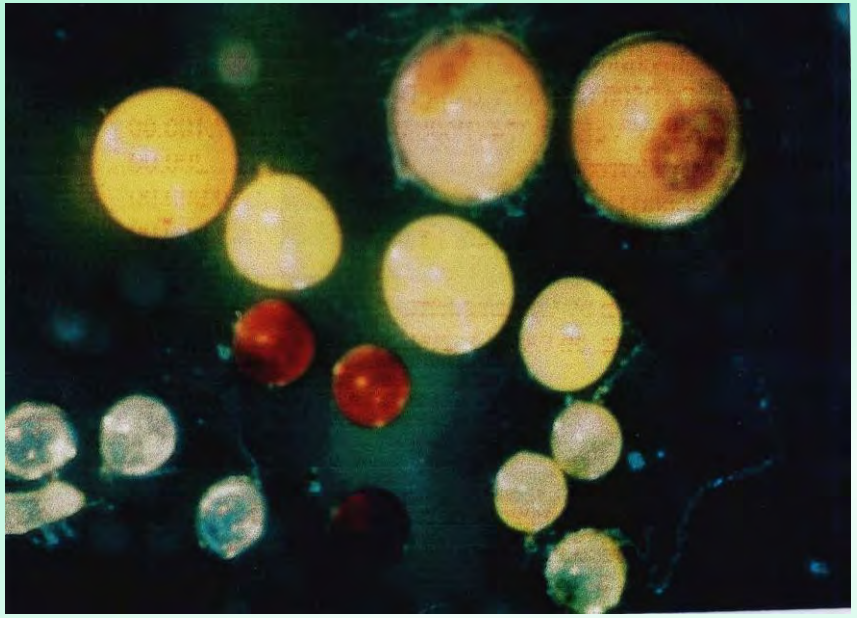
Why study mycorrhiza?

Benefits derived from mycorrhizal association:

- & increased absorption of nutrients: P, Cu, Zn, N, K, Ca
  - hyphae are able to extend beyond reach of root hairs important for poorly mobile elements & those bound by soil particles
- & increased drought resistance of plants
- & serves as biological control of root pathogens
  - utilizes surplus CHO thus reducing attractiveness to root pathogens
  - provides physical barrier thus prevent direct contact of root tissues
- & enhanced activity of other beneficial microorganisms
- & production of growth promoting hormones
- & improves soil structure by secreting mucilagenous substances

COMMON TYPES OF MYCORRHIZA

1. Vesicular-Arbuscular Mycorrhiza (VAM)



☺ found in all vascular plants: grasses, agricultural crops, fruit & forest trees

☺ belong to Zygomycetes (lower fungi)

☺ produce special structures:
vesicles (food storage)
arbuscules (site of nutrient exchange)

☺ cannot be cultured without the host

☺ penetrate inside cortical cells hence also called endomycorrhizal (endo = inside)

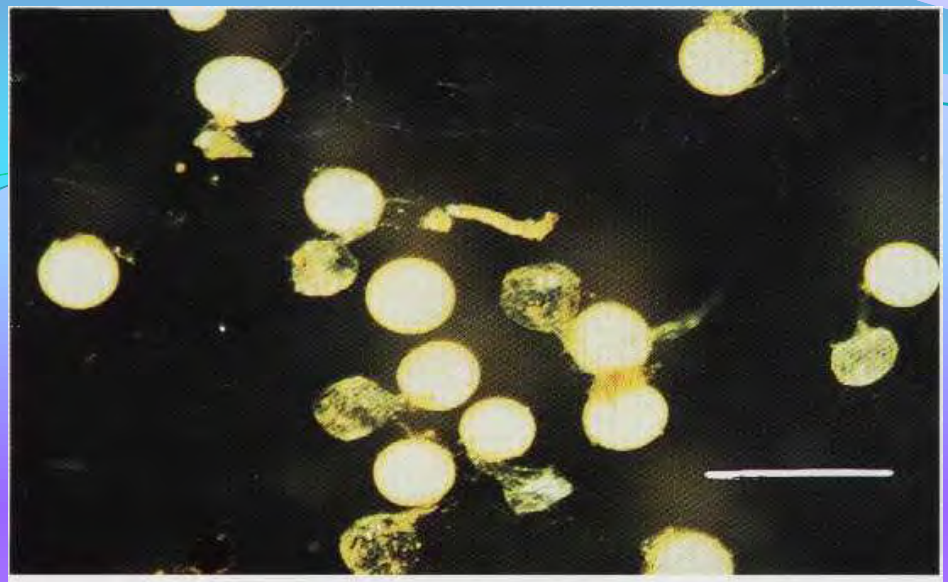


Fig. 1 Spores of *Acaulospora scrobiculata* in water (Bar=500 μm)

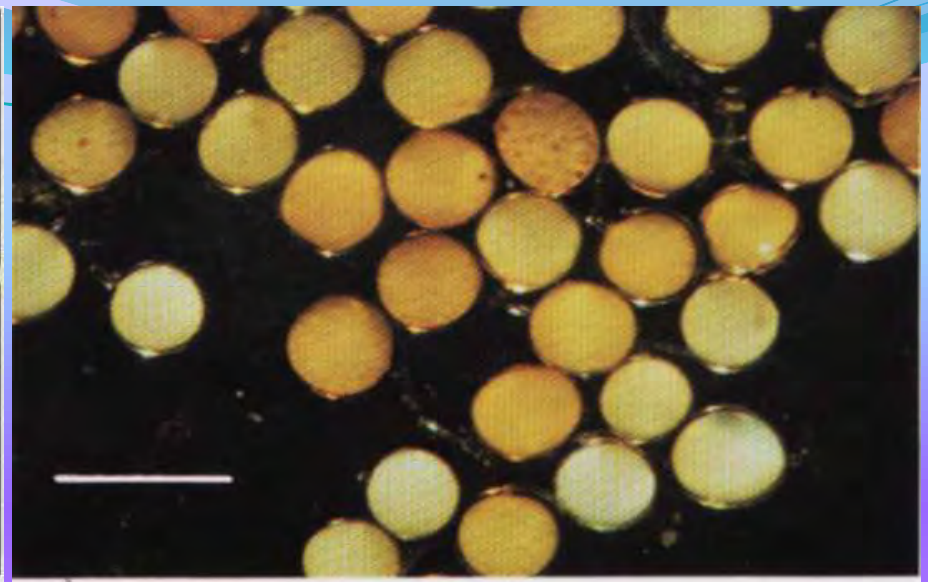
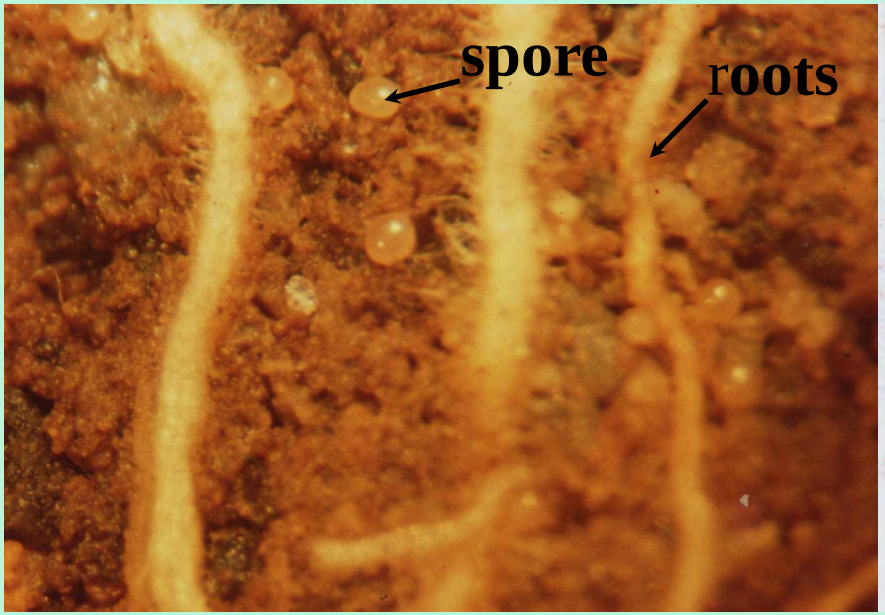
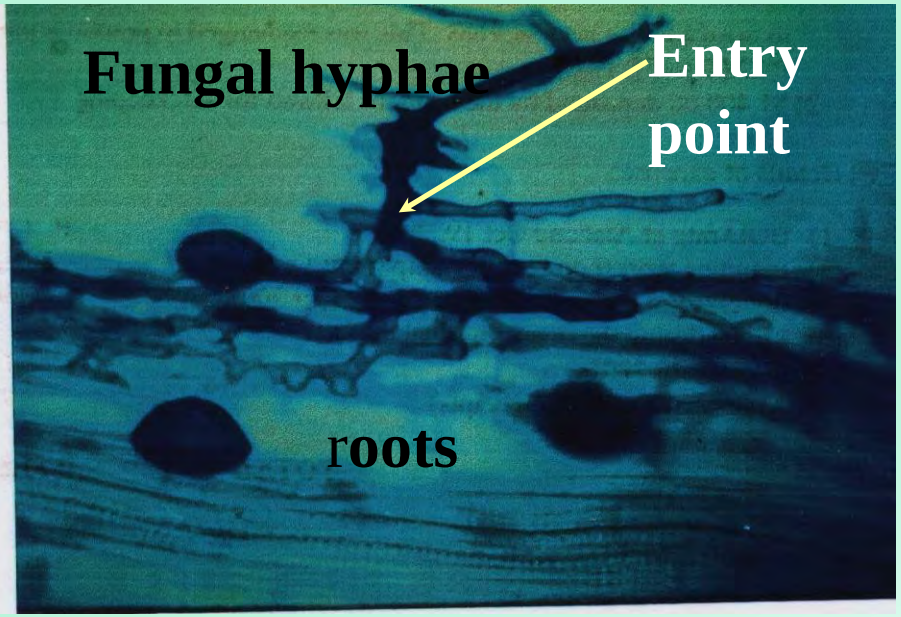


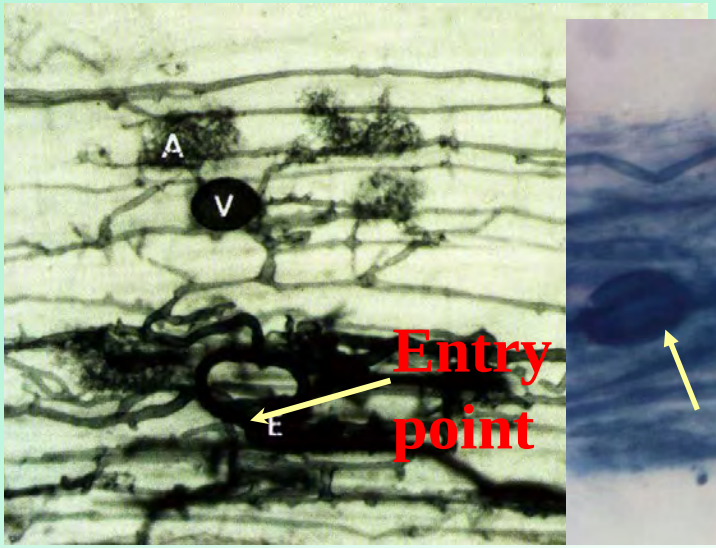
Fig. 2 Spores of *Glomus caledonium* in water (Bar=500μm)

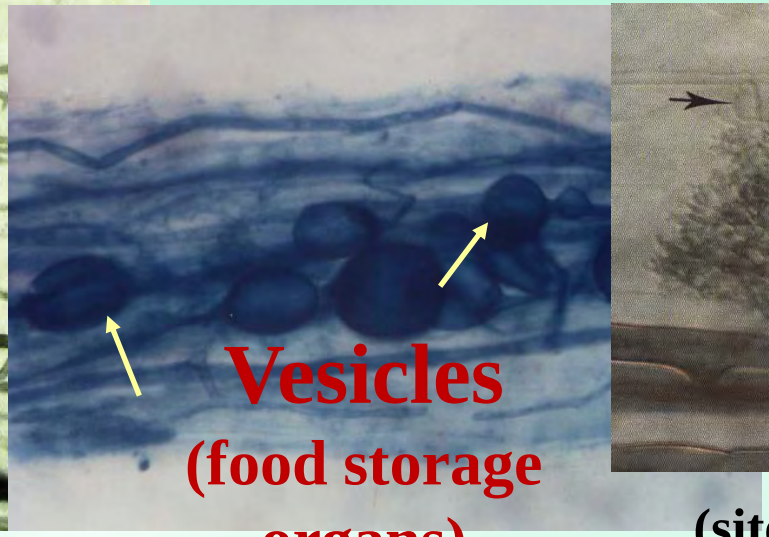
Fig. 3 Spores of *Glomus constrictum* in water

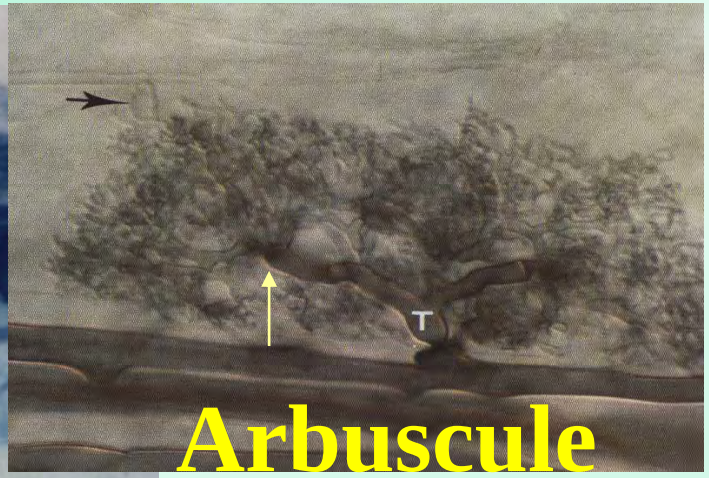
Fig. 4 Spores of *Scutellispora erythropa* in water









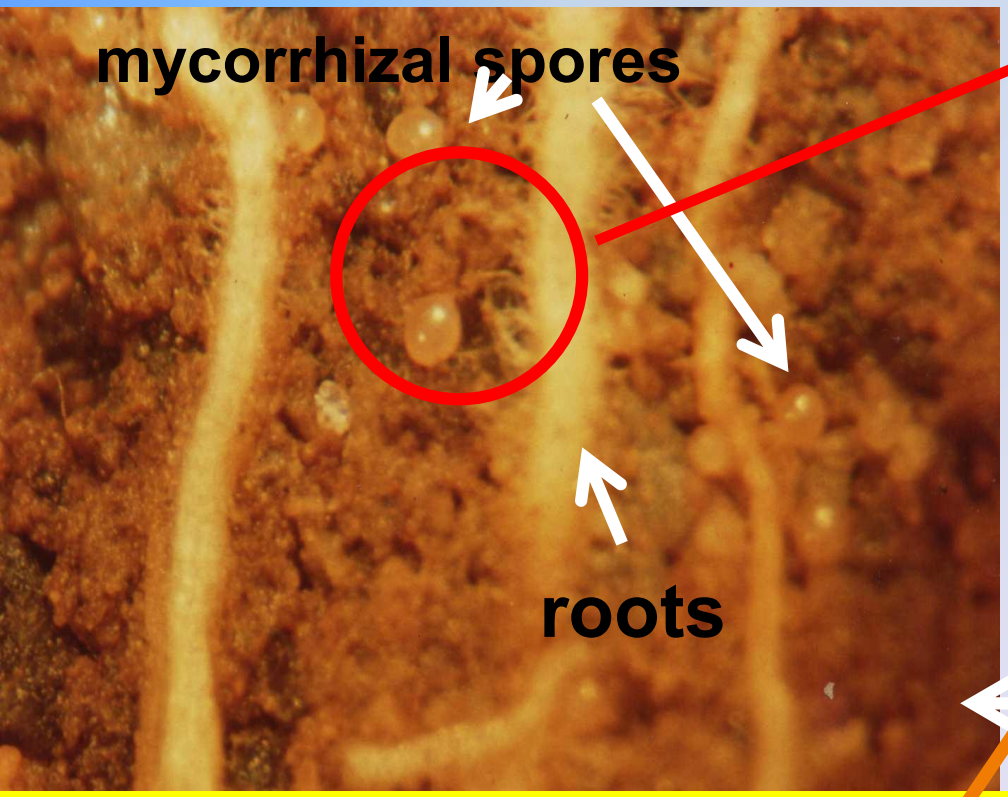


(site of nutrient exchange)

Brundrett et al 1996

Mycorrhiza

Mycor= amag **rhiza= ugat**



Each fungal hyphae serves as additional roots for greater nutrient & water absorption; also protects roots from pathogens

COMMON TYPES OF MYCORRHIZA….

2. Ectomycorrhiza (ECM)

☺ found in tree species such as pines, Dipterocarps, Casuarinas & Eucalypts

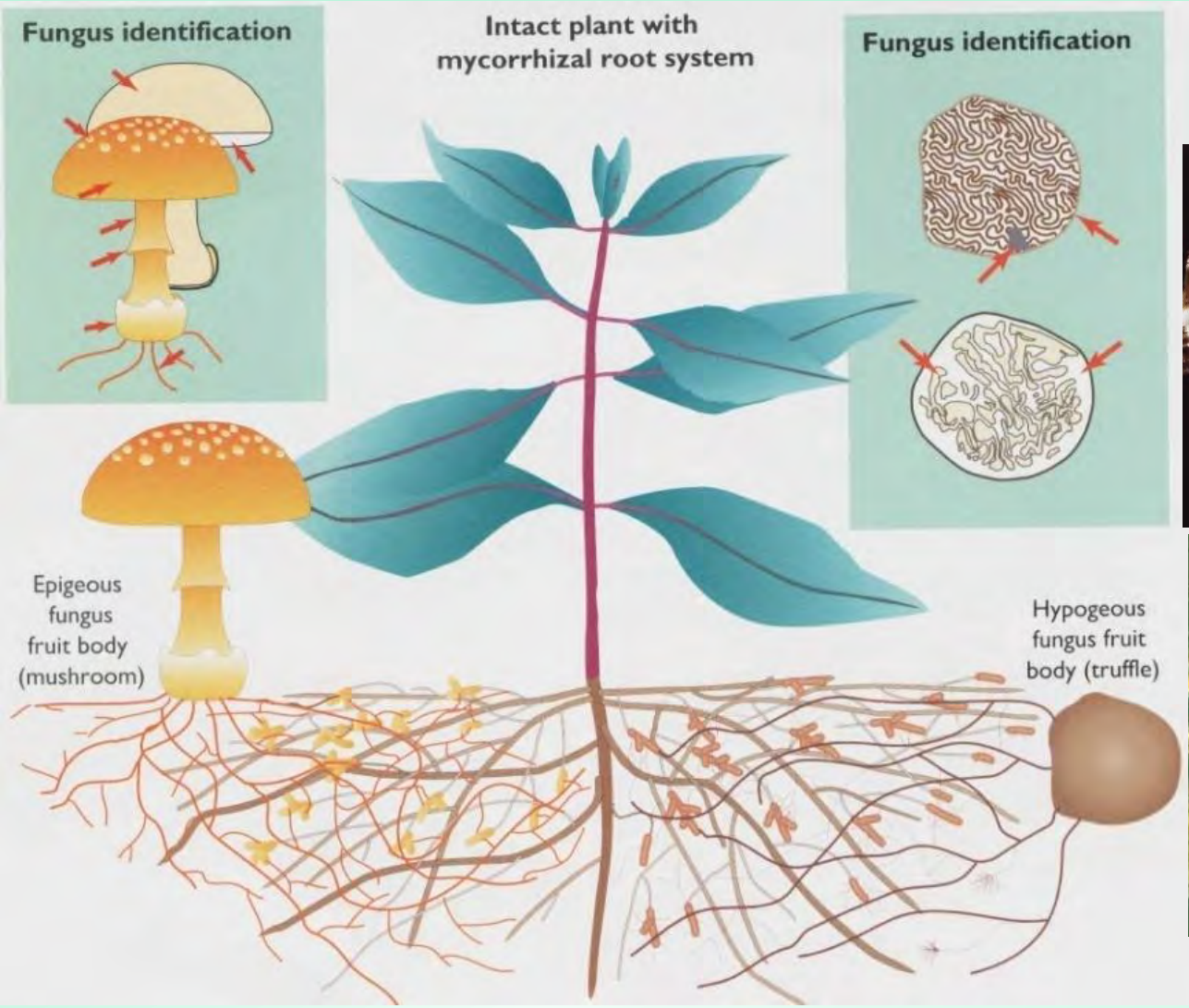
☺ belong to Ascomycetes & Basidiomycetes (higher fungi)

☺ infected roots are enlarged and covered with fungal mantle (rhizomorphs) & hartig net = sheath

☺ can be cultured in agar media

☺ does not penetrate cortical cells but just between cell walls hence just outside " ecto"

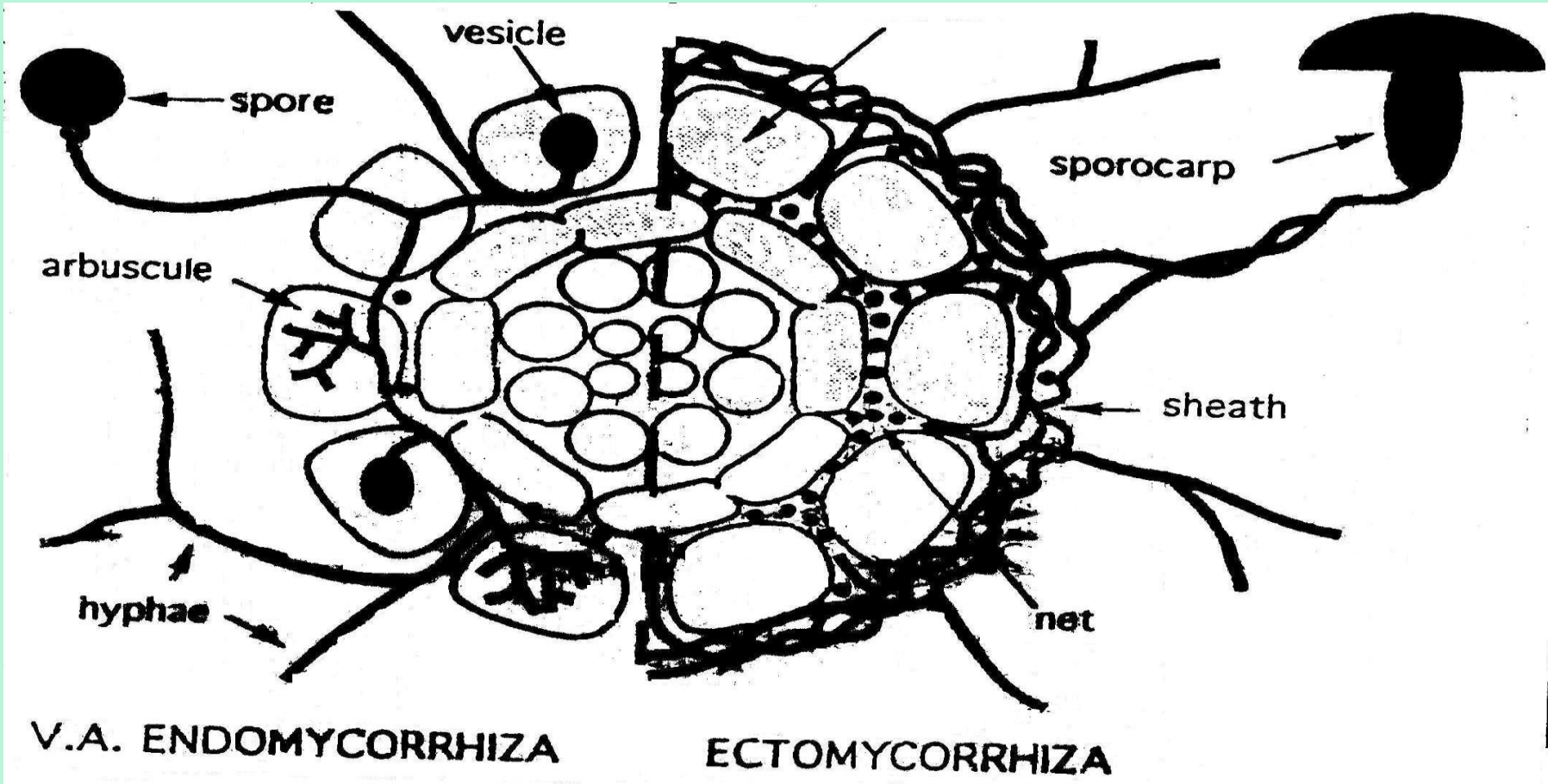
Ectomycorrhizal roots



Brundrett et al 1996

Sheath- cover

Summary of endo vs ecto mycorrhiza



Cross section of an ecto and endomycorrhiza.

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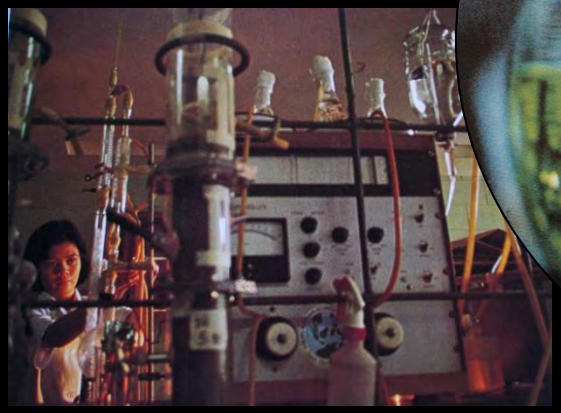
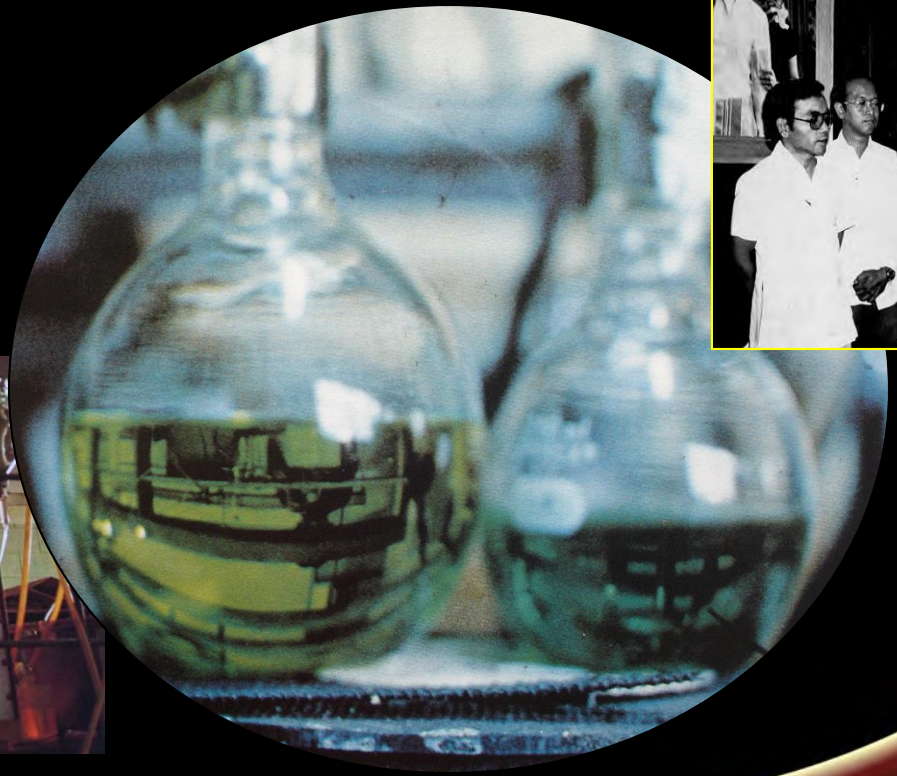
Birth of BIOTECH-UPLB…

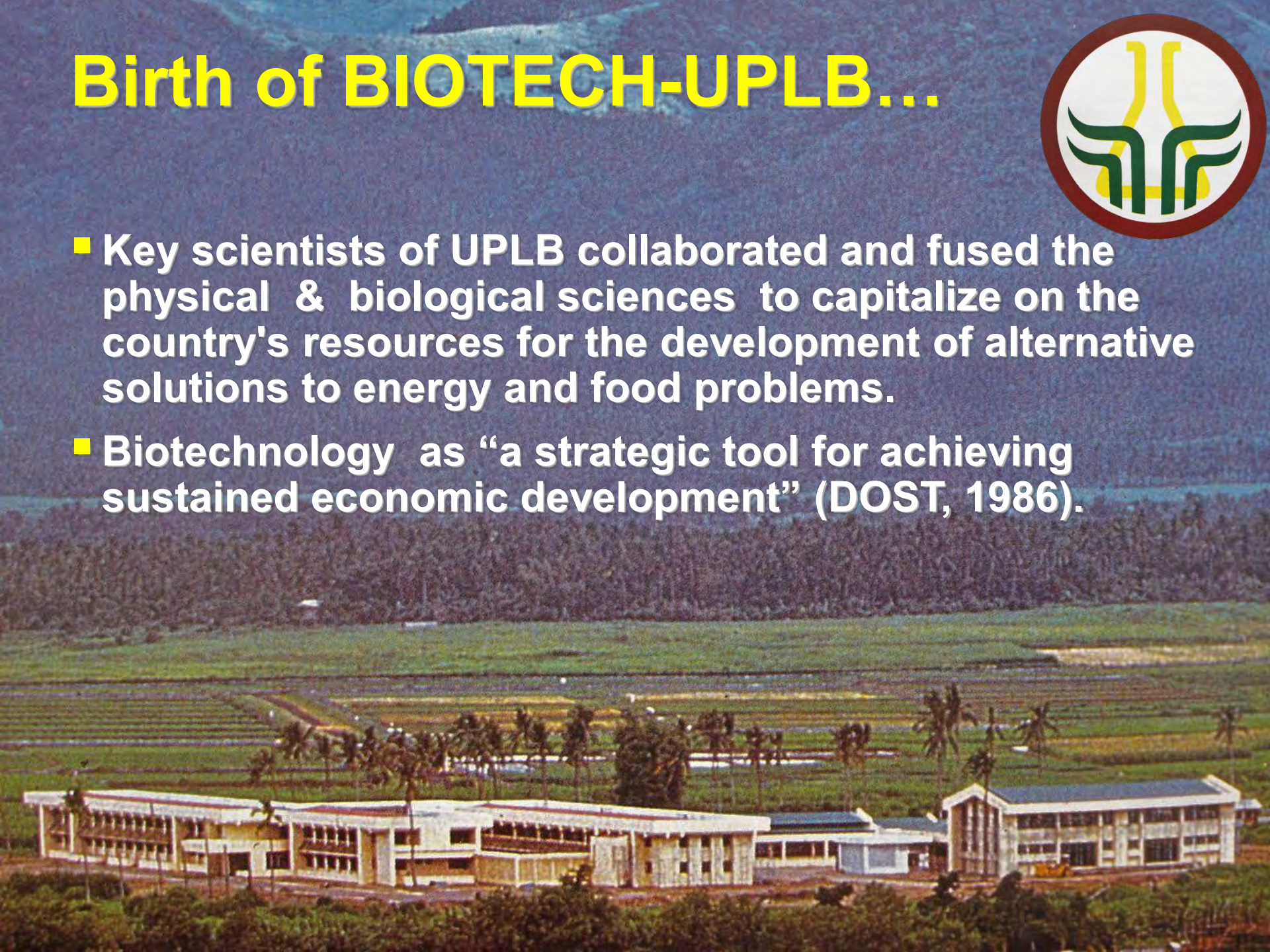
- The National Institute of Molecular Biology and Biotechnology (BIOTECH) was conceived during the energy crisis in 1970.





Birth of BIOTECH-UPLB…

- Key scientists of UPLB collaborated and fused the physical & biological sciences to capitalize on the country's resources for the development of alternative solutions to energy and food problems.
- Biotechnology as “a strategic tool for achieving sustained economic development” (DOST, 1986).



BIOTECH microbial inoculants

Biofertilizers – microbial inoculants with live or latent cells providing nutrients to *crops* ***i.e N fixer, P&K solubilizers, cellulose degraders***

Biostimulants – organic substances enhancing plant growth and development when applied in small quantities ***ie auxins, cytokinins, gibberellins***

Biopesticides- naturally occurring substances and microbials that can reduce population of insect pests and pathogens ***ie antibiotics, microbes with antagonistic properties***

Existing products

Concerns on Low Productivity

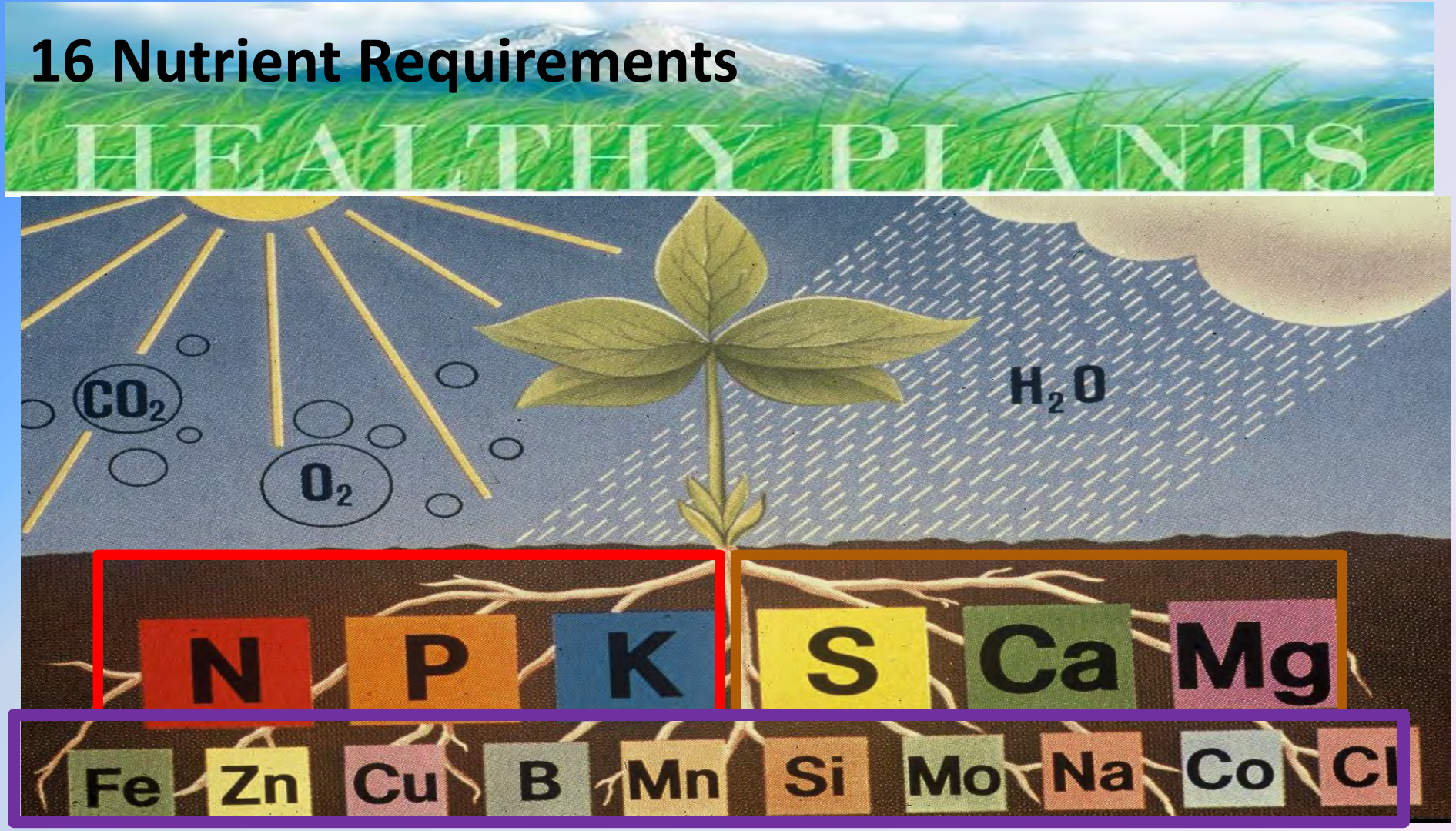
MORE FOOD

SUBSTITUTE and/or SUPPPLEMENT

IMPROVE SUSTAINABLE AGRICULTURE

Bringback soil health and biodiversity

16 Nutrient Requirements



Plants need all 16 elements in order to grow and provide yield

Yield limited by nutrient in shortest supply

Inoculation with mycorrhiza can very well support the supply of the limiting nutrient

The wooden bucket represents the soil's nutrient supplying capacity

Mycorrhiza research

beginnings……

Dr. Reynaldo E. dela Cruz
Father of Mycorrhiza research

- ✓ isolation
- ✓ identification
- ✓ Mass production
- ✓ Inoculation trials

Mycorrhizal Technologies in the Philippines

ENDO

Mykovam

VAMRI

ECTO

Mycogroe

MykoPlus

Vegetative mycelia

Brown magic

Hi Q VAM

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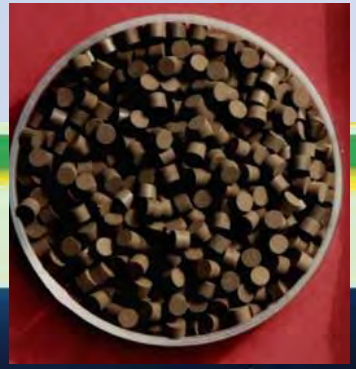
Inoculation trials



BIOTECH

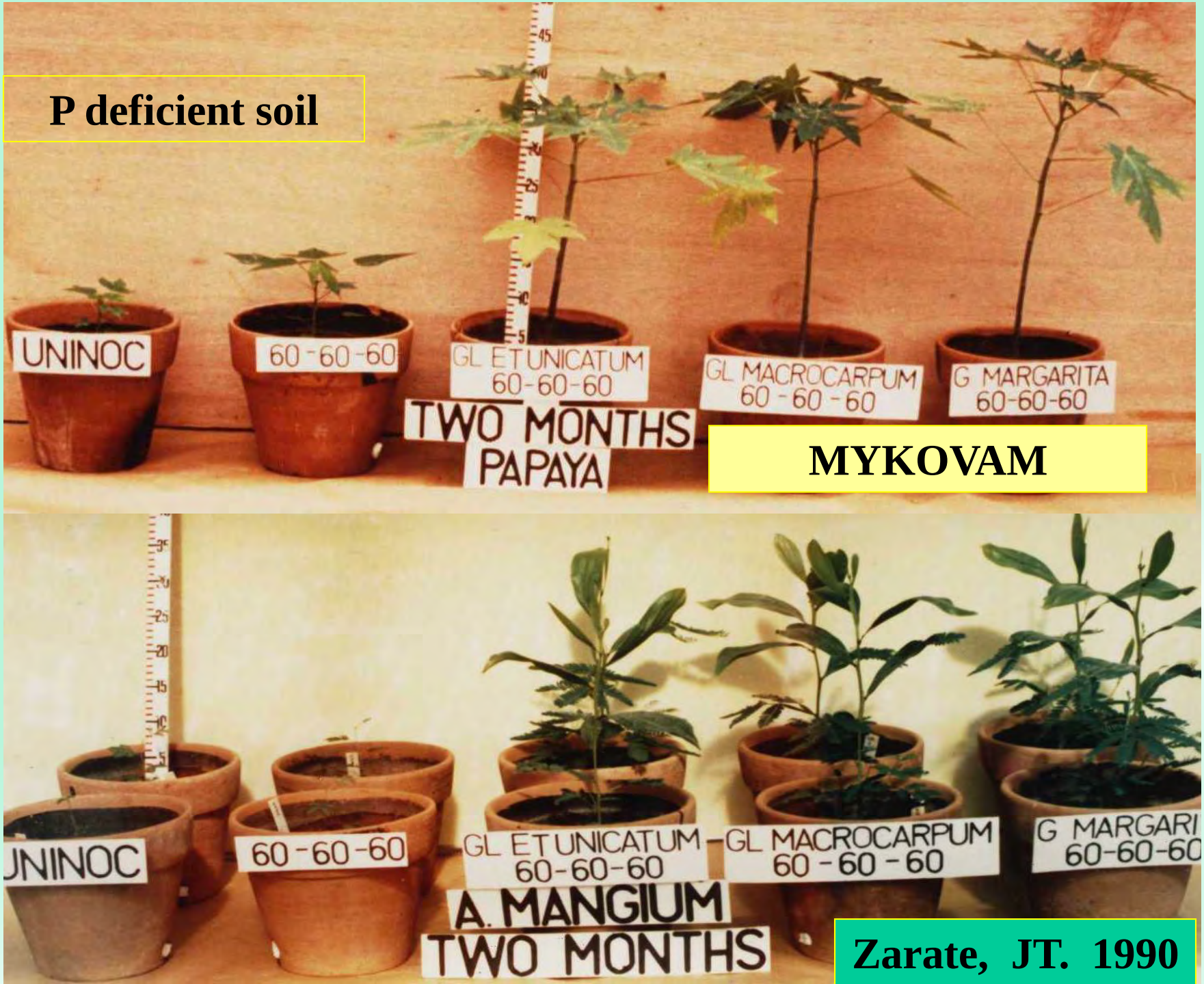
Dela Cruz, RE. 1987

Inoculation trials on Pinus carribea..
Dela Cruz, RE 1980s

Fertilizer and Mycogroe application trials on Eucalyptus deglupta Bislig, Surigao

Dela Cruz et al 1988


Phosphorus deficient soil
UNINOC
60-60-60
GL ETUNICATUM
60-60-60
GL MACROCARPUM
60-60-60
G MARGARITA
60-60-60
TWO MONTHS
EGGPLANT
UNINOC
60-60-60
GL ETUNICATUM
60-60-60
GL MACROCARPUM
60-60-60
G MARGARIT
60-60-60
PEANUT
TWO MONTHS
MYKOVAM
Zarate, JT. 1990


P deficient soil
UNINOC
60-60-60
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TWO MONTHS
PAPAYA
MYKOVAM
UNINOC
60-60-60
GL ETUNICATUM
60-60-60
GL MACROCARPUM
60-60-60
G MARGARI
60-60-60
A. MANGIUM
TWO MONTHS
Zarate, JT. 1990

How to use Mykovam?

- **Banding (5 – 10 g/plant)**

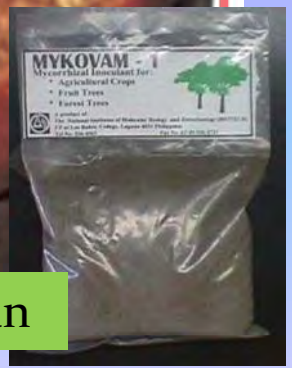
Uninoculated and MYKOVAM inoculated marang (A), langka (B) and honeydew (C)

NS Aggangan

Mykovam for growth promotion of banana

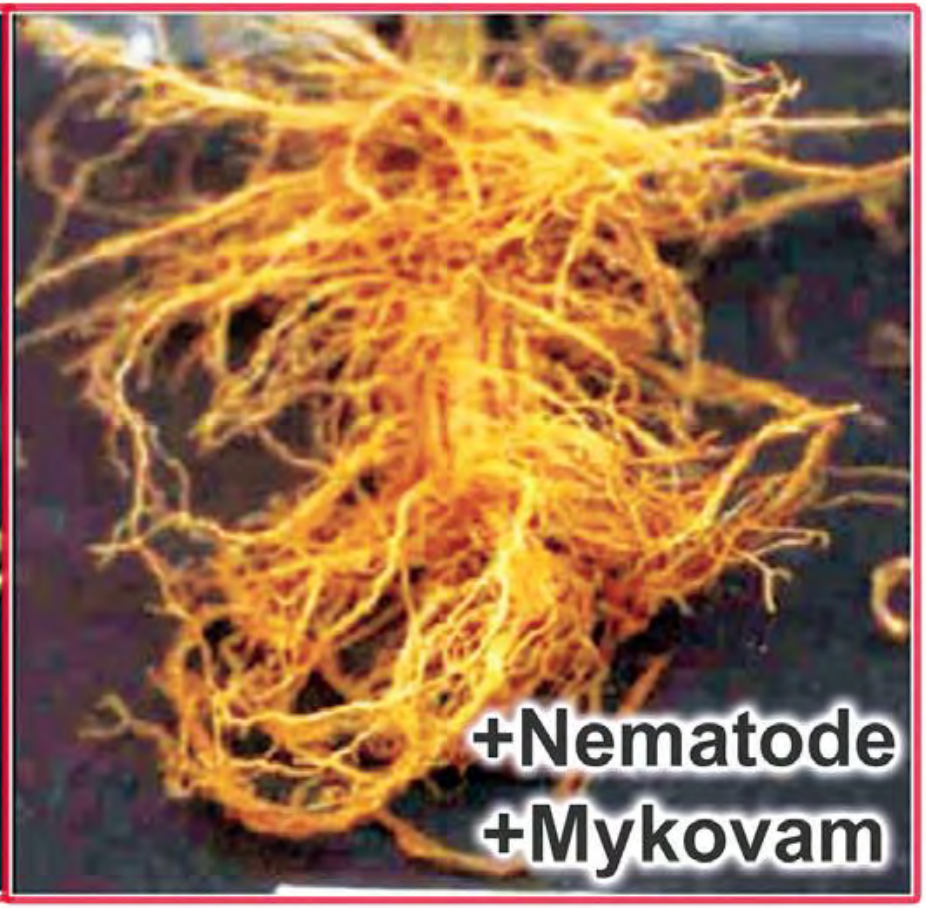
Source: NS Aggangan

Biological control of Mykovam in fusarium infested plant



Source: NS Aggangan

Biological control of Mykovam in tomato infested with nematodes



Source: NS Aggangan

Use in bioremediation (mine sites)

Biofertilizers' use in Bioremediation

Establishment of Jatropha plantation for biofuel in a mine waste dump site (Mogpog, Marinduque)

Chemical fertilizer alone

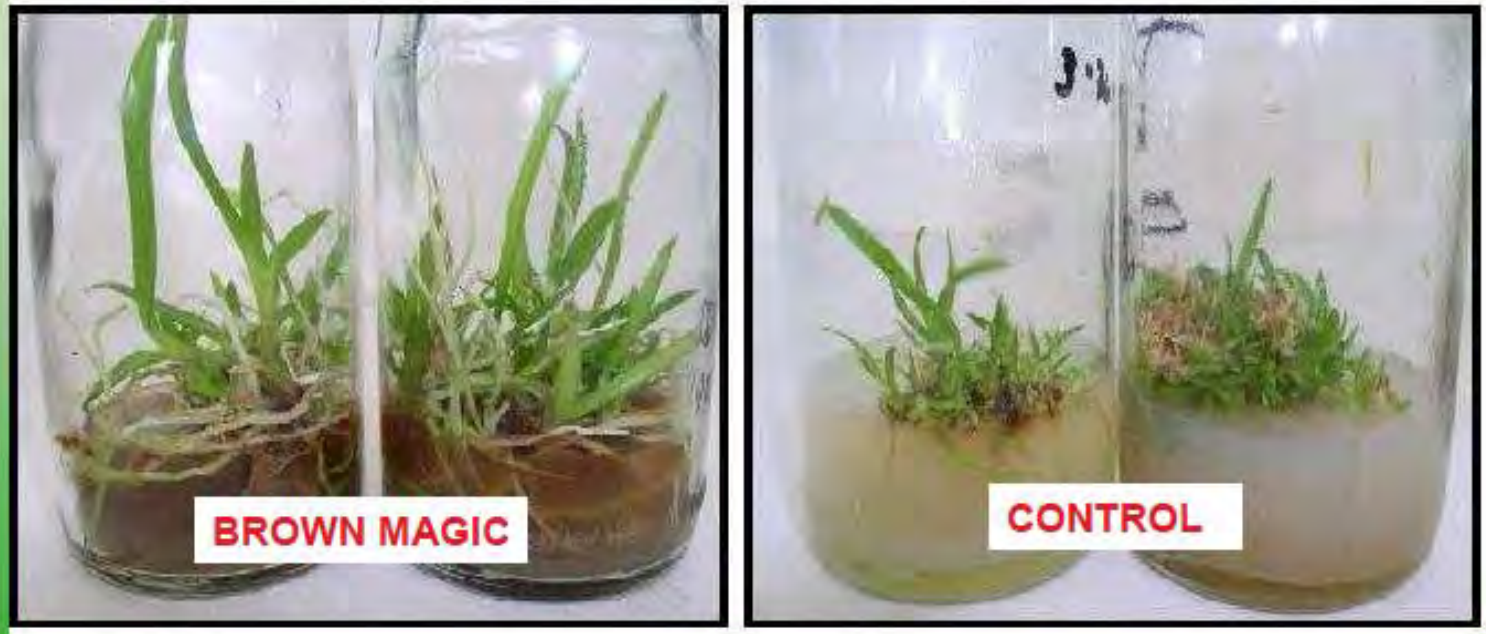
Biofertilizers plus soil amendments

Collaboration with RDA –Korea

Source: MB Brown

Crop growth promotion

Tissue-cultured orchids with Brown Magic



BIOTECH

Source: MB Brown

Collaboration with Non-Government Organization for coconut establishment

13 Coconut cooperatives, with Federation of Free Farmers

Source: JT Zarate

Banana- coconut intercrop (Bohol)

Control

Two years old coconut (Quezon)

Mycorrhiza + PGPR

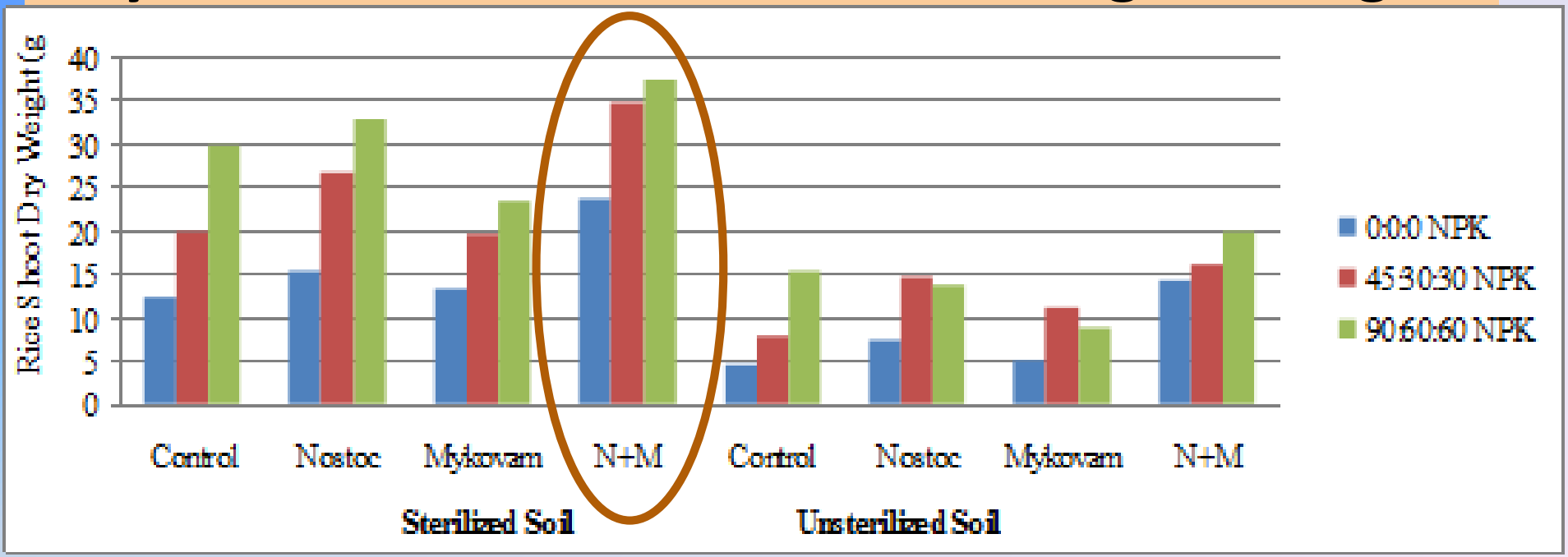
Hi Q VAM developed by DENR for the National Greening Program (NGP)

The inauguration of the DENR-ERDB Mycorrhizal Mass Production Facility was participated by DENR top officials and regional and bureau directors, and representatives from other DENR agencies and UPLB Science Community.

2012 Onwards

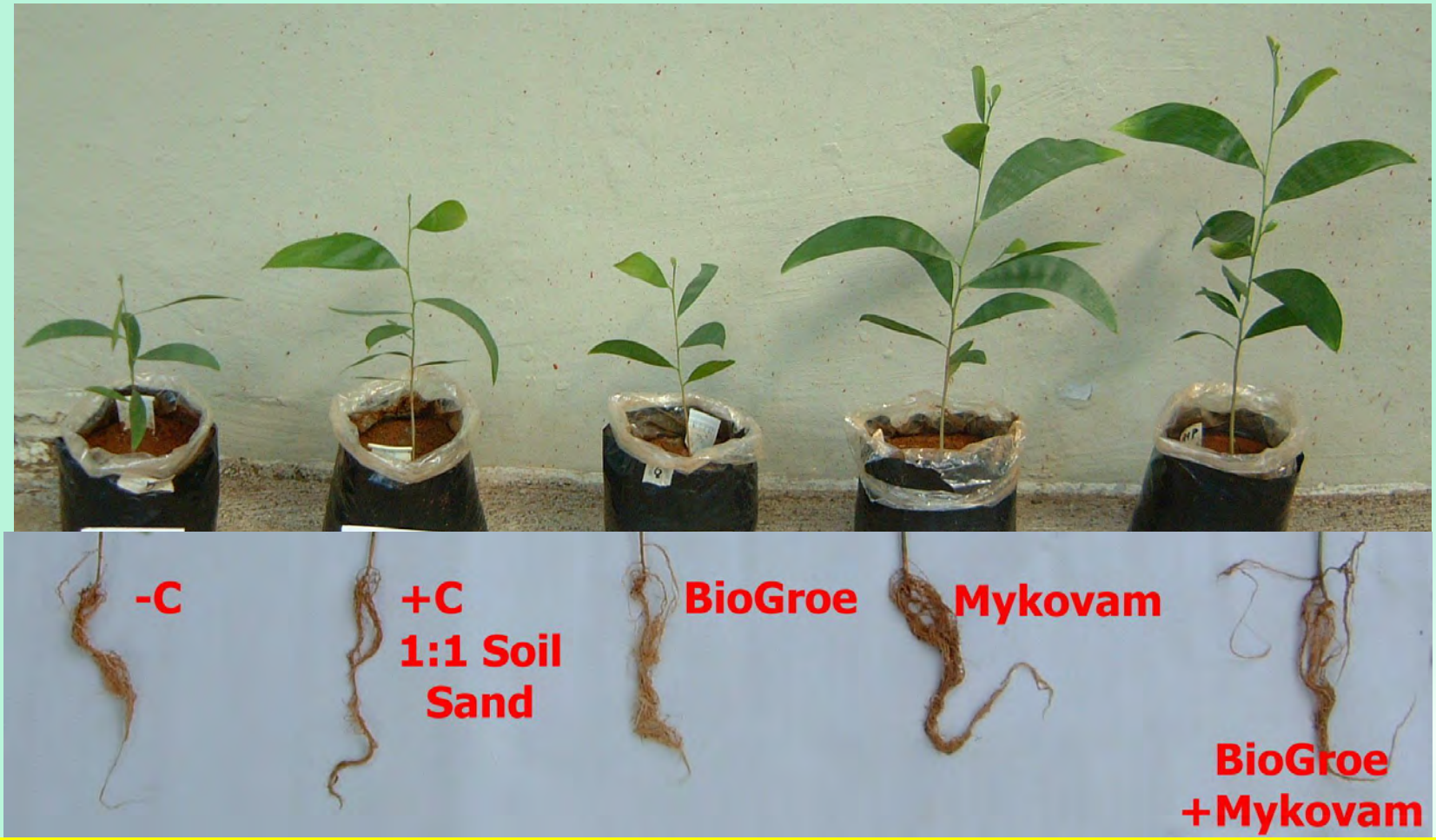
Interaction studies (Mycorrhiza and other microbes)

Paddy rice crop growth promotion with mycorrhiza in association with blue green algae



Pot trial on paddy rice

Source: JT Zarate with Nico Cedicol BS Thesis, UPLB



Acacia crassicarpa on Louisiana soil series

Interaction studies, mycorrhiza and PGPR

MykoPlus Biofertilizer

Solution to problems on low yield and income

Mycorrhiza

"mykes" "rhizaa"

Fungus - Root association

Plus

Other Microbes

N fixers

P solubilizers

Growth hormone secretors

serves as root extenders, root protection, provide active microbial diversity for healthier soil and plant

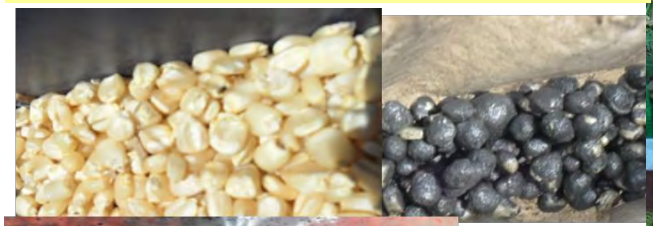
BIOTECH

MykoPlus application

300 g/pack

- Good seed germination
- Increase uptake of water and nutrients
- Better growth
- Higher yield & income

✓Coated on seeds



✓Coated on planting materials (cane points, tubers)

✓ Soil treatment on germination medium

MykoPlus

(Mix Microbial Biofertilizers)

More complete approach to crop productivity problems

Farmers practice 120-28-28

Farmers practice 128-28-280 + MykoPlus

Eggplant and bell pepper

Source: JT Zarate

Crop growth promotion

Higher seed germination in Lettuce plants with MykoPlus

BIOTECH

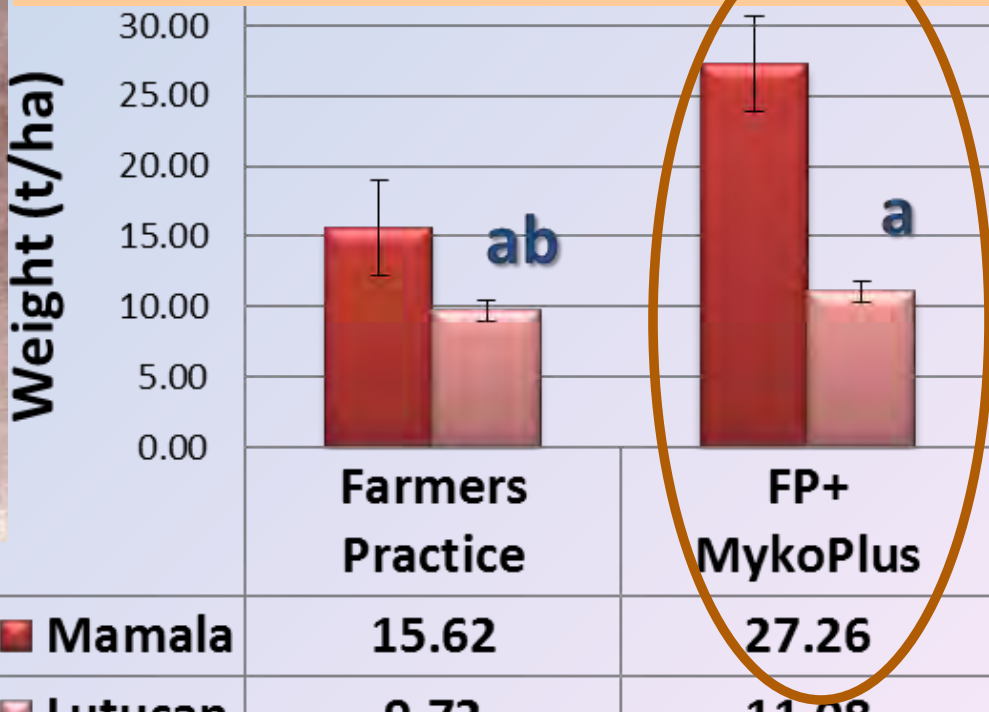
Source: JT Zarate

Cassava tuber production

Farmers practice (Foliar spray)

FP + MykoPlus

Cassava field trial in 2 sites with FP and FP+ MykoPlus treatment



	Farmers Practice	FP+ MykoPlus
Mamala	15.62	27.26
Lutucan	9.72	11.08

3rd Field trials on cassava

Leafy vegetable and fertilizer interaction studies

Lettuce cv Green span at harvest (8 plants per tray)

Bell pepper

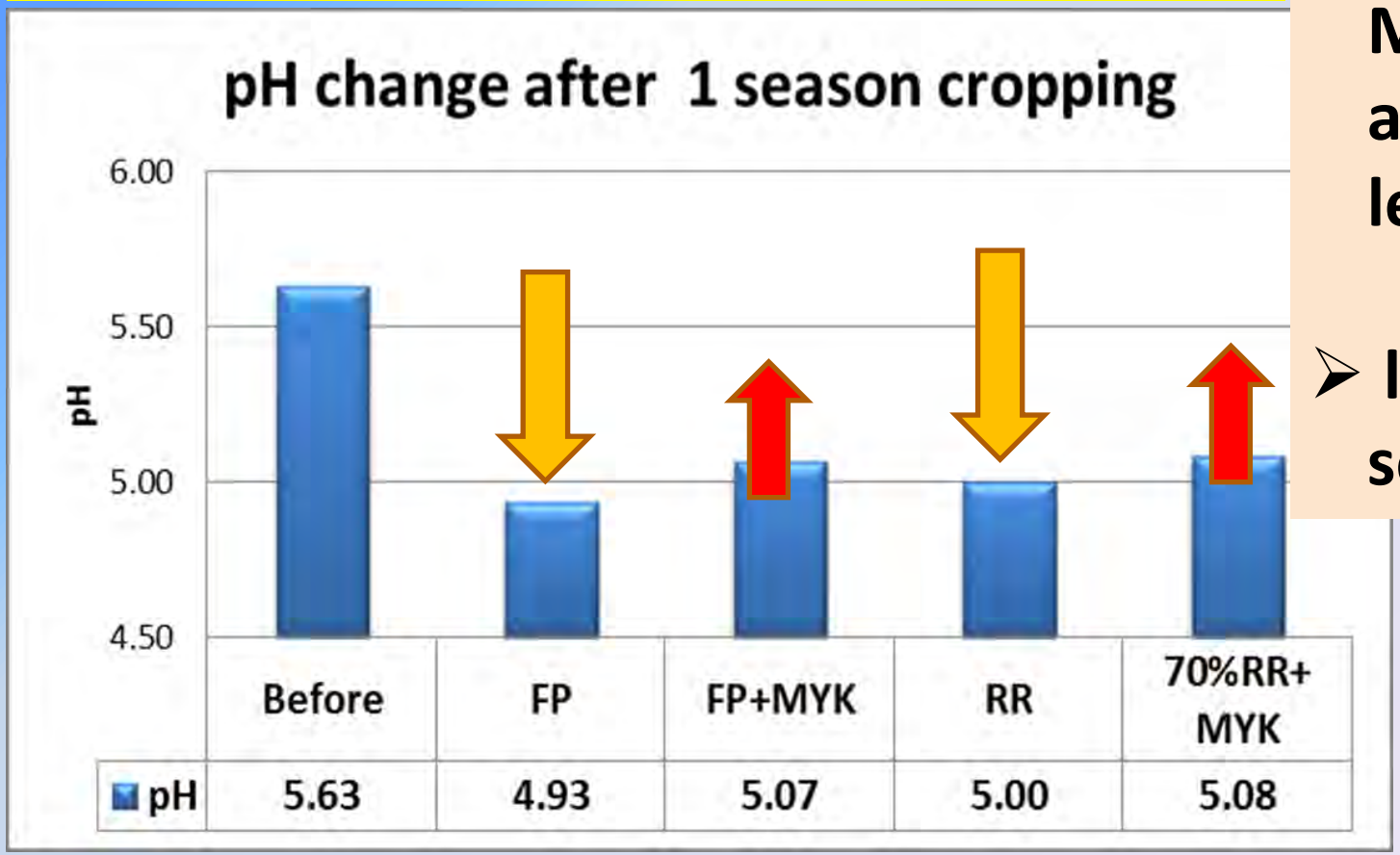
Lettuce

Results in other crops

- ✓ Early flowering
- ✓ Enhanced fruiting
- ✓ Drought resistance

Eggplant	Farmer's practice (Fertilizers)	Fertilizers + MykoPlus	Effects
Fruit Yield kg/ha)	2,675	3,407	27% inc
Total Production Cost (US $ /ha)	520.11	542.84	
Gross Income (US $)	2,431	3,097	
Net Income (US $)	1,911	2,554	34% inc

Soil properties are improved

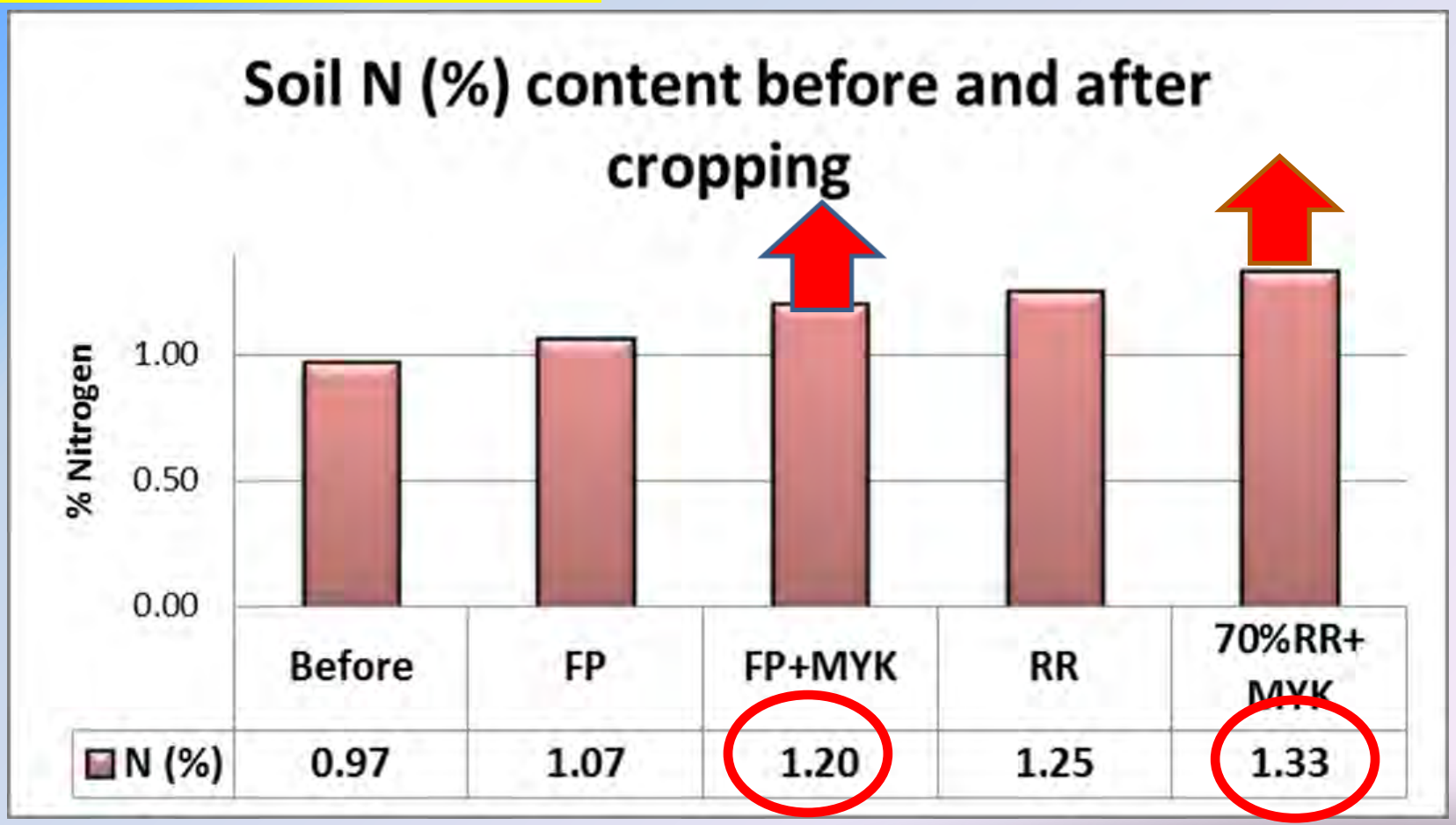


- with MykoPlus soil acidity is lessened
- less acidic soil

BIOTECH

Soil properties are enhanced:

- Soil N is higher in MykoPlus applied plots



Other activities

IEC materials

Seminars/Symposium

RR

70% RR + MykoPlus

30% savings in chem fertilizers N P and K

Inoculation effects of Mycorrhizal Products

- Better seed germination
- Taller height
- More vigorous growth
- Higher yield
- Higher income for farmers

- Lesser fertilizer application
- Better survival in field sites
- Better resistance to pest, pathogens, heavy metals
- Preservation of the environment

Current Trends

- Continue trials and optimization of use of MykoPlus
- Participation of government and industry to support commercialization of mycorrhizal products for reforestation and agriculture
- Microbial community analysis
- Intellectual property protection (IP)

Recommendation

- Need for more collaborative research, to fully study and explore mycorrhizal technologies

- Need to disseminate technologies and educate farmers/users of the use of mycorrhizal technologies

Acknowledgement

SEAMEO BIOTROP
SEARCA Los Baños
UPLB BIOTECH
DOST PCAARRD
DOST PCIERRD
Students and staff

"Let us be like the tulips, always lifting up our petals in all praise to our Maker."

Thank you very much for your attention!