



Joint FAO/IAEA Centre
Nuclear Techniques in Food and Agriculture

Innovative Plant Breeding for Climate-Resilience with Induced Genetic Diversity - A GLOBAL CONTEXT

**The Joint FAO/IAEA Centre of
Nuclear Techniques in Food and Agriculture**

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Plant Breeding and Genetics
Jun 2023*

Plant Breeding & Genetics at the Joint FAO / IAEA Center

Demand-driven research innovations, applications

Develop improved, climate-change adapted, crop varieties for food and nutrition security, reduced poverty through nuclear and related biotechnologies

- **Induced genetic variation**
- **Genomics**
- **Precision phenotyping (selection)**
- **Speed-breeding technologies**
- **Seed systems for farmers' access to new varieties**

Delivered through: **Coordinated Research Projects** *and*
Technical Cooperation (TC) Projects





Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Contributing to:

SUSTAINABLE DEVELOPMENT GOALS

2 ZERO
HUNGER



3 GOOD HEALTH
AND WELL-BEING



1 NO
POVERTY



13 CLIMATE
ACTION



15 LIFE
ON LAND



CURRENT TC PROJECTS at PBG: National **53**, Regional **11**



LATIN AMERICA
26

EUROPE
24

AFRICA
42

ASIA/PACIFIC
34

PBG Coordinated Research Projects



BINA
D20003

NIAB
D20004

FGTU
D24015

Disease Resistance
D23032

Pulses
D22006

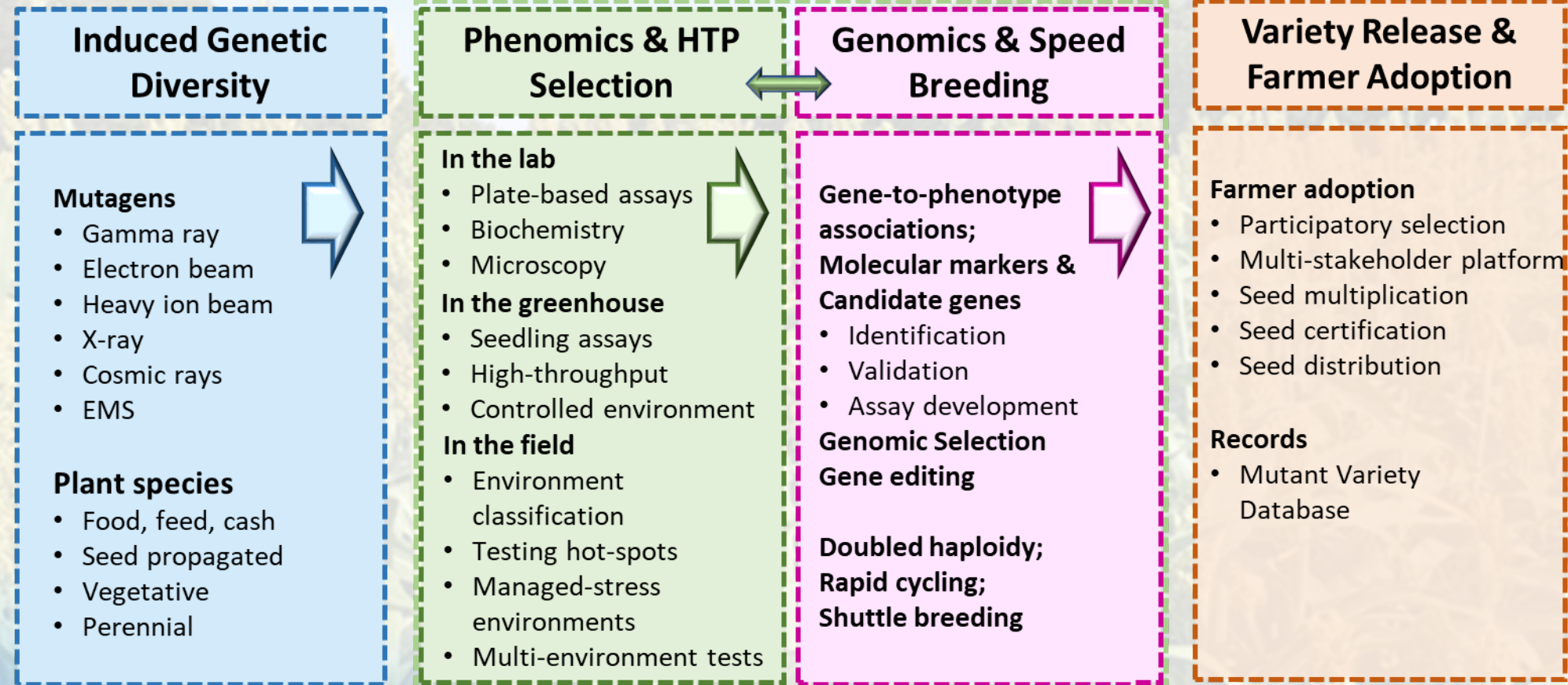
VPC
D24014

INDUCED GENETIC DIVERSITY FOR CROP IMPROVEMENT

Local, National IMPACT

*Food & Nutritional Security,
Farmers' Income*

Increased crop
production



Induced Genetic Diversity – Mutagen Source

Newer mutagen sources: **ion beam**,
electron beam, **cosmic rays**

Can **cosmic radiation** and
microgravity trigger mutations for
better climate-change adaptation?

Effect on **DNA structural variants** with
different mutagen sources.





Induced Genetic Diversity – Seed Crops

Mutation breeding is applied predominantly to seed crops

Target traits:

- Grain yield
- Drought tolerance
- Heat tolerance
- Disease resistance
- Resistance to insects
- Resistance to weeds
- Grain quality
- Forage digestibility
-

Improvement of Seed Crops for Climate Resilience

- Improvement of food, feed and cash crops
- Yield enhancement, yield stability under climate change, produce quality



Drought tolerant groundnut
in Sudan



Heat tolerant cotton in
Pakistan

Improvement of Seed Crops – Insect Pest Resistance

Induced genetic diversity for pest resistance Non-Bt alternative where necessary

- Resistance to Fall Army Worm in Maize
- Resistance to chickpea pod borer, *Helicoverpa armigera*
- Resistance to cowpea pod borer, *Maruca vitrata*



Photo: CIMMYT



Photo: Thudi M, ICRISAT



Photo: Dhanasekhar P, BARC

Improvement of Vegetative and Perennial Crops

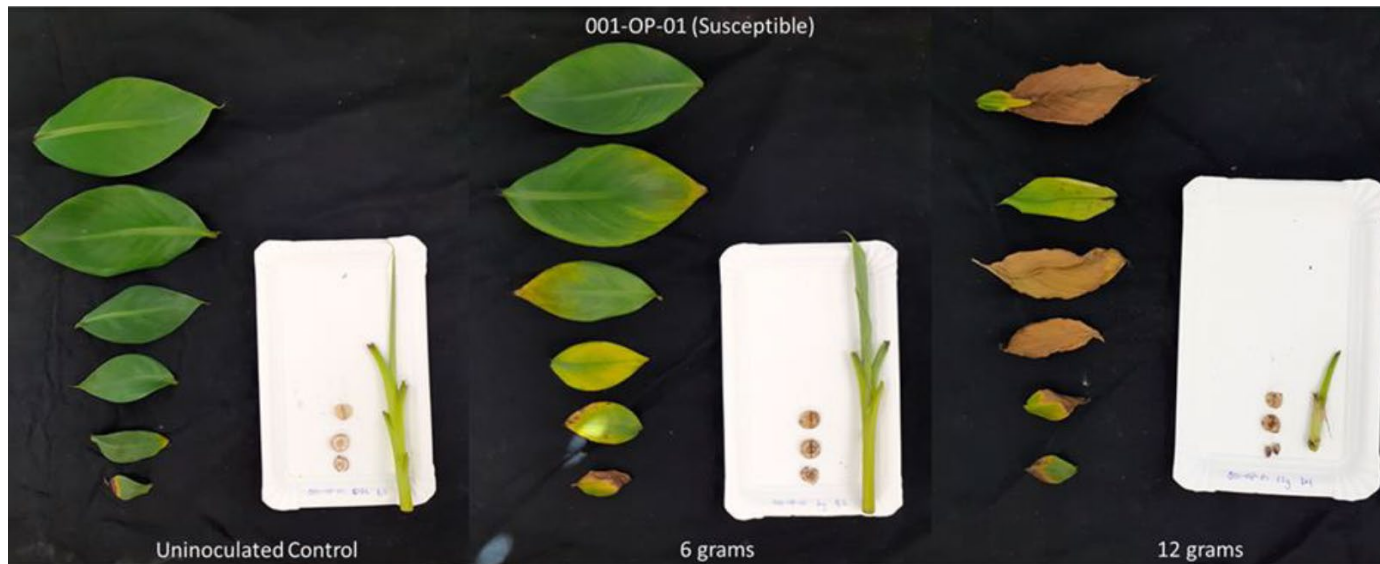
- Improvement of vegetative crops and perennial crops has been traditionally challenging
- Existing genetic variation very narrow
- Induction requires the use of tissue culture, micropropagation



Cassava, potato, sweet potato, fruit trees....

Improvement of Vegetative Crops – Disease Resistance

Developing banana varieties resistant to the **Fusarium Wilt foc TR4**, a devastating disease



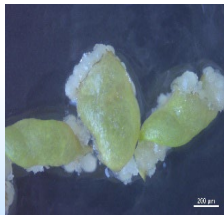
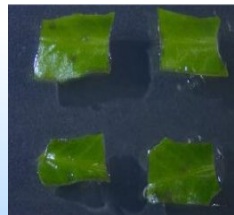
Screening for resistance under controlled greenhouse conditions



Field testing for resistance to TR4

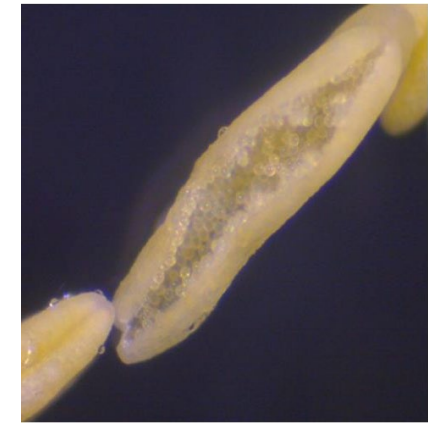
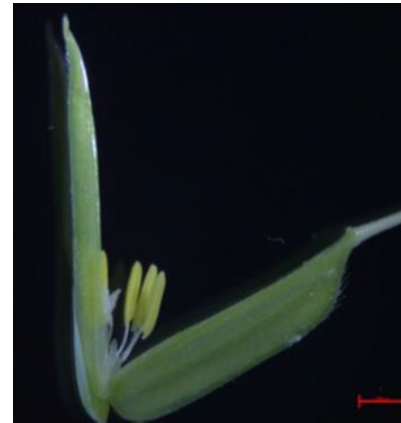
Improvement of Perennial Tree Crops – Disease Resistance

Coffee mutagenesis, variant discovery – against the **Leaf Rust** disease
single-cell mutagenesis, exome capture



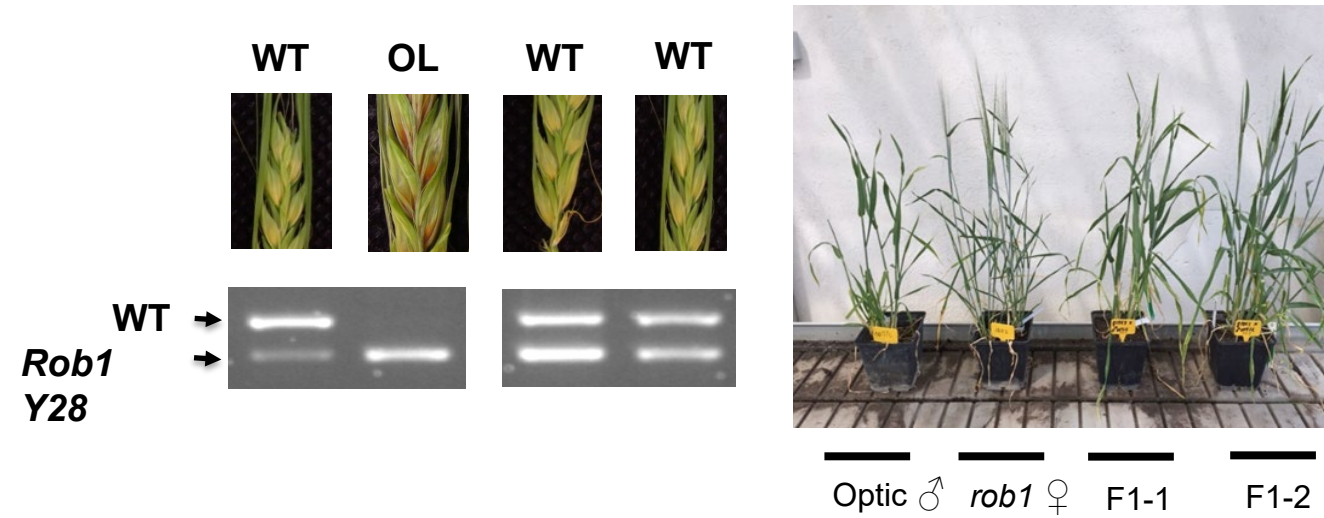
Speed Breeding

- ❑ Shorten time for variety development
 - Doubled haploidy (Rice)
 - Rapid generation advancement (RGA)
- ❑ 5 generations of lentil in a year with RGA at FAO / IAEA greenhouses
- ❑ Rice variety in MS from irradiation to release – 5 years

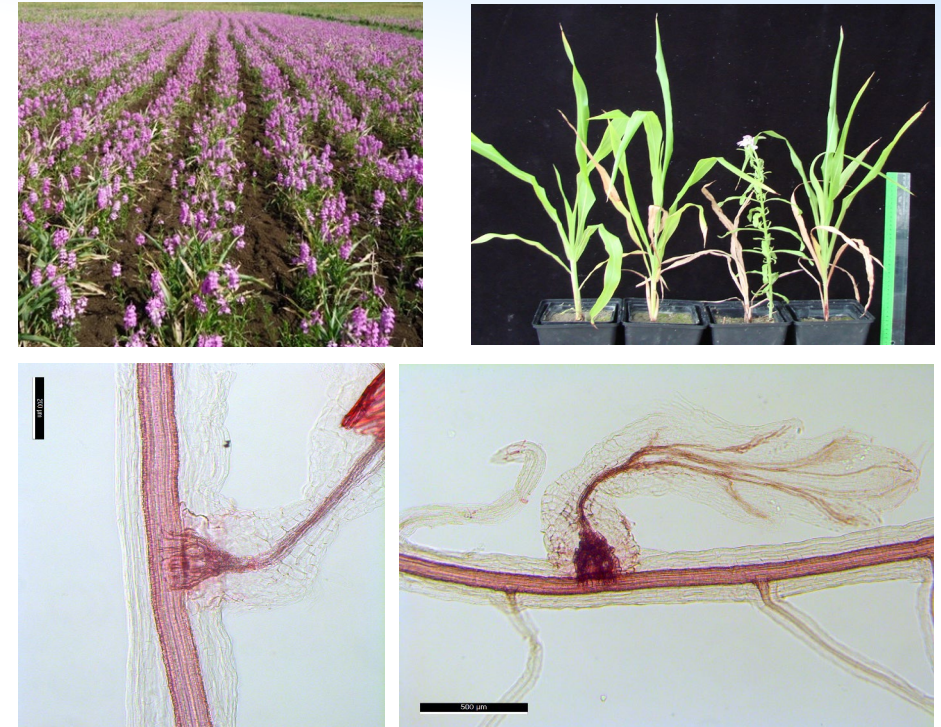


Functional Genomics for Trait Utilization (FGTU)

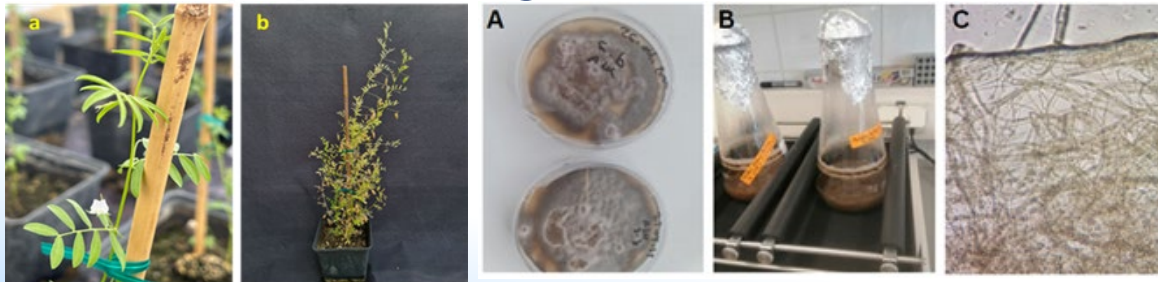
Marker development for barley grain digestibility



Striga resistance in sorghum



Stemphylium blight resistance in lentil



Capacity Building

- Fellowships, Internships, Group Training at national and regional levels
- Protocols, Kits



DNA extraction, PCR



Coffee Exome Capture kit

Recent Success Stories in Crop Improvement



31 May 2022

Tackling **Cassava Brown Streak Disease in Uganda** with Nuclear Techniques



1 June 2020

Drought-tolerant crops: IAEA and FAO help Zambia improve production and farmers' income



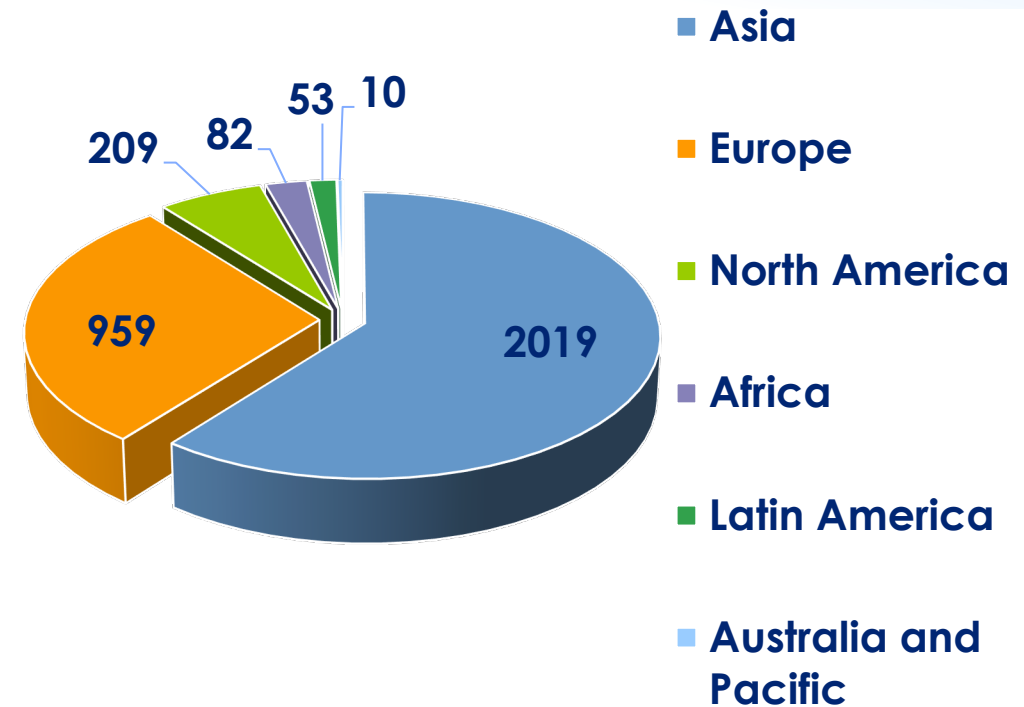
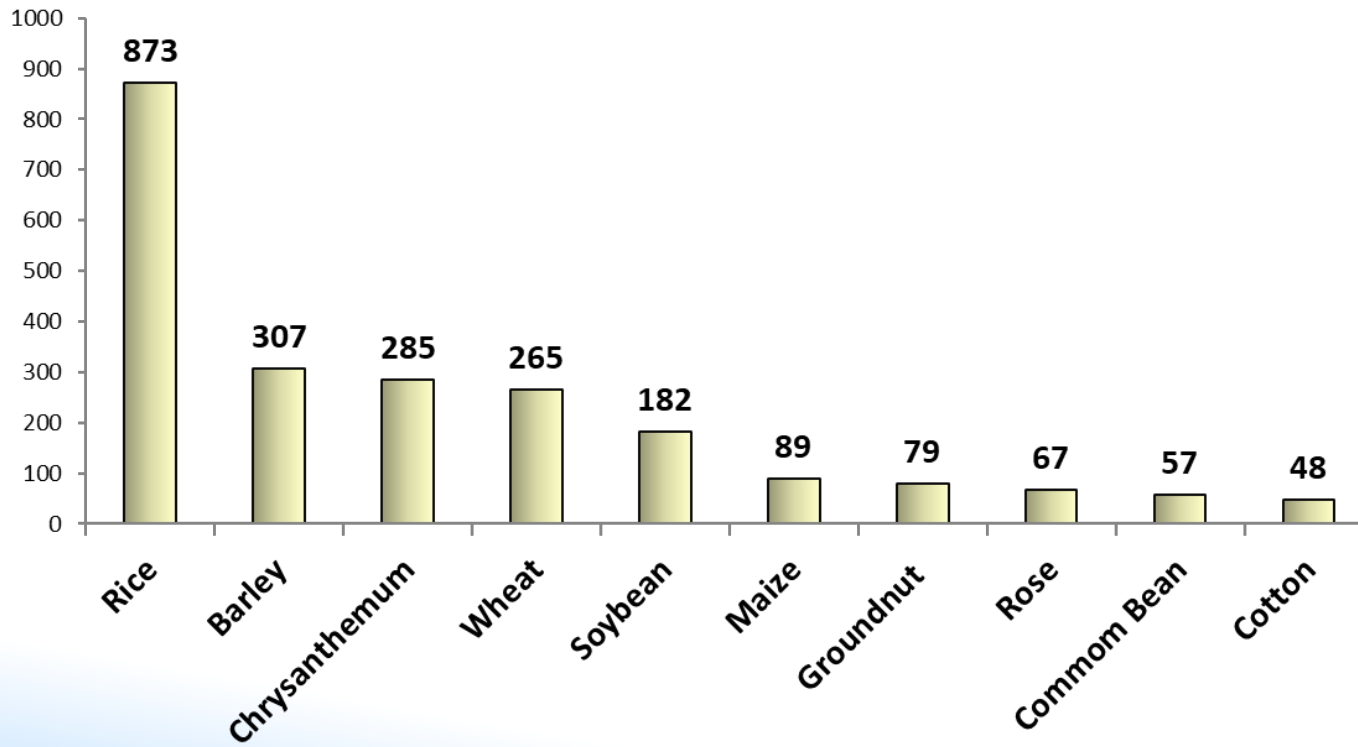
5 September 2019

Nuclear Techniques Help Develop New **Sorghum Lines Resistant to the Parasitic Weed Striga**

FAO / IAEA Mutant Variety Database (MVD)

~3400 released varieties across 72 countries and 238 species

Top ten crops in MVD





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Thank You

FAO/IAEA Agriculture and Biotechnology Laboratories