Presentation:
Robert M. Boddey
robert.boddey@embrapa.br

Director:
Eduardo Campello
eduardo.campelo@embrapa.br
Embrapa Agrobiology’s Mission

To generate knowledge, technologies and innovation supported by agrobiological processes in benefit of a sustainable agriculture for the society”
Importance of Biological N2 Fixation in soybean in Brazil

Production- Harvest 2012 = 81,000,000 t. (IBGE)
Yield 2,900 kg ha\(^{-1}\), Estimate of N fixed = 4,900,000 Mg.
Price of N as urea = ~R$2,550,00 or US$ ~1,600,00.
This N\(_2\) fixation is thus worth US$ 6.5 billion year
Biological Nitrogen Fixation (BNF)

BNF is the process of conversion of atmospheric $N_2$ ("dinitrogen") to ammonium by living organisms.

Plots of soybean planted in Rio Grande do Sul 40 years ago, inoculated or not with Bradyrhizobium spp.
Competences and Research Lines

**Plant growth promoting microorganisms**
1. Selection of plant growth promoters
2. Use and management of soil organisms in agricultural systems
3. Development of technologies for inoculation of microorganisms for agricultural use

**Biochemistry and Genetics**
1. Microbial Diversity
2. Functional Genomic
3. Plants and microorganisms characterization of gene expression
4. Bacteria-plant Interaction

**Nutrients Cycling**
1. BNF quantification
2. N using efficiency by plants
3. C and N Balance in agricultural systems
4. Emission of greenhouse gases and SOM accumulation
5. Energy balance and Modeling agricultural processes

**Organic Agriculture**
1. Participatory research methods for improving technological transference
2. Biological control for pests on cultivation systems
3. Management of M B for organic, green manuring and composting strategies
4. Technologies for growing vegetables and coffee
5. Impacts of agroecological systems in forest fragments

**Reclamation of degraded areas**
1. Physical, chemical and biological Indicators to evaluate the environmental services
2. Survey and selection of efficient interactions among plants, bacteria and mycorrhizas
3. RDA of mining and agricultural areas
4. Forest and Agroforestry systems
5. Selection of biological indicators
Some advances in RDI

- **Genome Project - completed sequenced**
  - *Gluconacetobacter diazotrophicus*, strain PAL5 - isolated from sugarcane. Genome size - 3,999 Mb.

- **Functional genome project of G. diazotrophicus (pós-genomic era)**
  - Metabolism of nitrogen
  - Quorum sensing genes;
  - Phytohormones pathway (IAA, Giberellins, etc)
  - Osmotolerance regulation;
  - Bacteriocins;
  - Polysaccharid genes;
  - Gluconic acid pathway;
  - Promoter trapping sequences;
  - Unknown functions
Some advances in RDI

**Functional genomic analysis of the endophytic diazotrophic**
**Glucanacetobacter diazotrophicus** strain PAL5

Exopolyssaccharide (gumD) gene is involved in the initial steps of root colonization

Adsorption and anchoring colonization phases of *G. diazotrophicus* strain PAL5, mutant MGD and restored strain in roots of rice seedlings

Effect of EPS addition (from the wild-type PAL5 strain) on the colonization of rice roots by the MGD mutant of *G. diazotrophicus*

Adhesion of the rice root surface by the *gfp* labeled strains of *G. diazotrophicus* (wild-type, EPS mutant and restored strain).

Meneses et al, 2010
Some advances in RDI

Inoculant for sugarcane

2 companies to commercialize the technology for sugar cane inoculant use of the Embrapa trade mark.

5 packs containing 1250 g of peat + bacteria (mixed with clean water)
Some advances in RDI

Selection of *rhizobium* and *arbuscular mycorrhizae* for *Mimosa artemisiana*

100 kg/ha de N
Strain SMF 1382
Control
Road embankment
Niteroi - RJ

18 meses
Some advances in RDI

Land Reclamation

Comperj: 300,000 seedlings

Projetos 2011-12

» Olympic compromise to neutralize CO2 emissions. INEA-COB

» 2 Books

Reclamation of degraded areas in the semi arid region
Survey of N$_2$O emission rate from Brazilian agriculture: Studies in development and programmed by Embrapa Agrobiologia

- Flooded rice
- Sugar cane
- Evaluation of N sources and Residues
- High land rice, ZT
- Irrigated maize and bean, ZT
- Pig slurry and chicken manure
- Maize and soybean crops
- Pasture and cattle excreta
- Residues
- Sugar cane
- Forest, eucalyptus and pasture
- Crop rotation (maize, soybean and wheat, ZT and CT)
- Crop rotation (soybean and wheat, ZT and CT)

Integration cropping-pasture

Pig slurry
Some advances in RDI

Impact of Brazilian cattle in the nitrous oxide emissions
Some advances in RDI

N₂O emission by cattle in urine and feces at Cerrado conditions

» The data indicate that the emission factor for N in urine and feces are much lower than 2% of the value proposed by the IPCC.

» Under conditions of extensive pastures of the Cerrado, rarely more than 60% of N is excreted in the urine, so the emission factor would be around 0.5 to 0.7%.
Some advances in RDI

Technology of biomass elephant grass as a renewable energy source: used by red ceramic industry

» Productivity and quality selection of genotypes for energy production

» Total Partner institutions: Cerâmica União de Campos; Embrapa Agrobiologia; IPT-SP

There are a variety of genotypes with different potential growth (20 – 70 t/ha year) performance depends on soil and climate
Some advances in RDI

**Cutting and drying in field**

- Energy balance and greenhouse mitigation
- Total power generated: 22 kcal to each kcal fossil applied
- Mitigation of greenhouse gases (replacement of natural gas): 9 tonnes of CO₂/Ton. brcks produced
- Economy (R$) 70% compared to the use of natural gas in Rio Janeiro
Organic farm

(Fazendinha Agroecológica)

A joint venture between Embrapa-Agrobiologia, the federal Rural University and PESAGRO – the Rio State Agricultural Research Institute

DIVERSIFICATION

INTEGRATION

BIOLOGICAL NITROGEN FIXATION

Amendoim forrageiro
Infrastructure – Laboratories (19)

- Nitrogen and Isotopes ($^{15}$N e $^{13}$C)
- Gas chromatography for GHGs
- Organic Agriculture
- Soil organic matter
- Enzymes
- Biological control
- Soil fauna
- BNF Leguminous Trees
- Collection of cultures
- Microbial Ecology

- Soil and Plant analyses
- Electronic and optical microscopy
- Micorrizas
- BNF Grasses
- Genetics/Biochemistry
- Genome
- Molecular Techniques – Multi-user
- Inoculant Development
- Inoculant Production
Inoculant for Cowpea

**Grain Yield**

- **Non Inoculated**
- **40 Kg N ha**⁻¹
- **80 Kg N ha**⁻¹
- **Strain BR 3262**
- **Strain BR 3267**
- **Strain BR 3299**
- **Mixture 3267/3299**

**Field station experiment**

**Pod yield (kg ha**⁻¹**)**

- **Non-inoculated**
- **40 kg N ha**⁻¹
- **80 kg N ha**⁻¹
- **Strain BR 3267**
- **Strain BR 3299**

**Planting on-farm**

**Technology transferred**

The result: Cowpea
Embrapa Agrobiology Staff

Total: 144 employees: 42 researchers (most of all PhD), 36 analysts (undergraduate) and 66 support
Thank you!