Alliance

Bioversity International

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

Potential of rice cultivars to mitigate methane emissions in LAC, using genetics for mitigation

Maria Fernanda Alvarez

PhD. genética y fitomejoramiento

m.f.alvarez@cgiar.org

CGIAR

Paul A. S. Soremi[1,2,3], Ngonidzashe Chirinda[1,4], Eduardo Graterol[2], Maria F. Alvarez[1]

[1]*International Center for Tropical Agriculture (CIAT), Palmira, Colombia.*

[2]*Latin American Fund for Irrigated Rice (FLAR), International Center for Tropical Agriculture, Palmira, Colombia.*

[3]*Department of Plant Physiology and Crop Production, Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.*

[4]*AgroBioSciences (AgBS), Agricultural Innovations and Technology Transfer Centre (AITTC), Mohammed VI Polytechnic University (UM6P), Ben Guerir, Morocco*

This research was supported by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) and the Global Research Alliance on Agricultural Greenhouse Gases (GRA) through their CLIFF-GRADS program. CCAFS is carried out with support from CGIAR Trust Fund

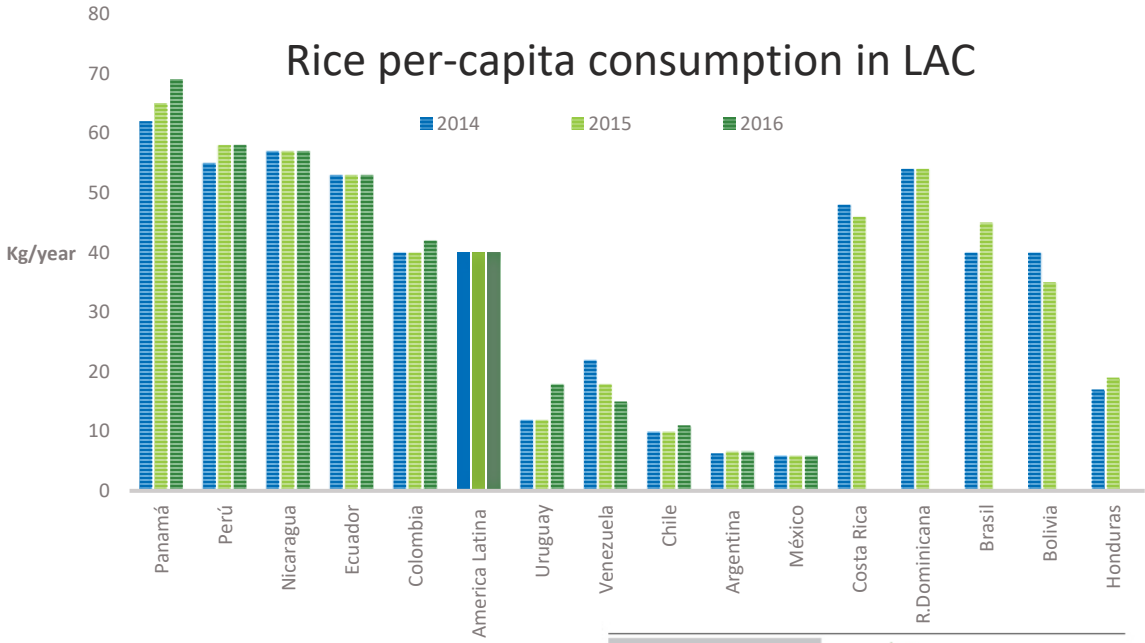
Rice in LAC

- High per/capita consumption up to 70 Kg/years
- Increasing urban population
- Rural poverty up to 45%
- The rice production and yield tripled in last 50 years
- 80% of the planted are under DRS

COVID-19 impact in LAC

The regional economy will contract 5,3 %

the poverty rate will increase in 4,4%

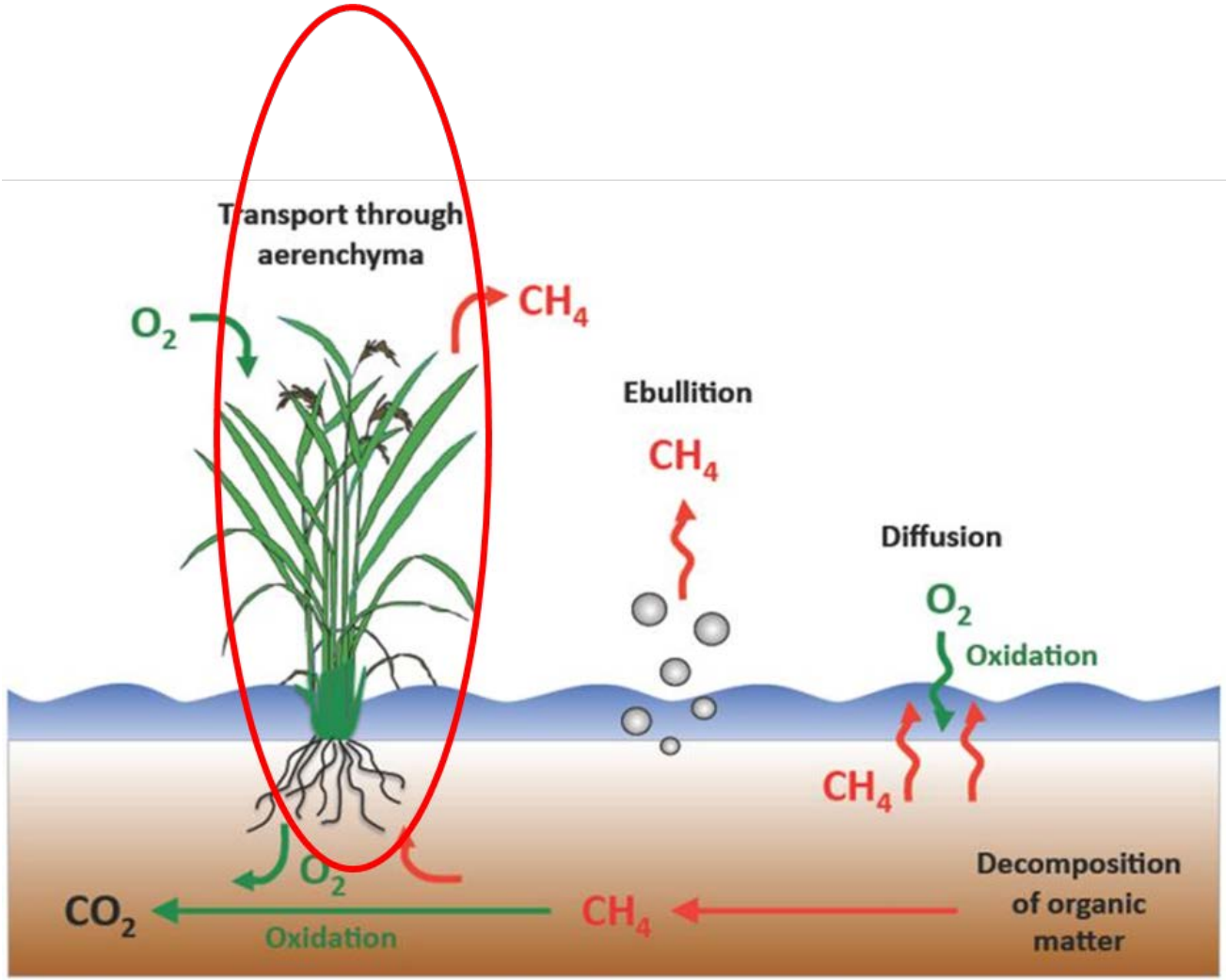


Source: Andrade, R. Labarta, R. 2017 – FLAR members survey

Alliance

Bioversity International

CIAT



Methane oxidation:

$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$

Methanogenesis:

- Hydrogenotrophic: $CO_2 + 4\ H_2 \rightarrow 2\ H_2O + CH_4$
- Acetotrophic: $CH_3COOH \rightarrow CO_2 + CH_4$

nature COMMUNICATIONS

ARTICLE

https://doi.org/10.1038/s41467-021-27424-z OPEN

Check for updates

Sustainable intensification for a larger global rice bowl

Shen Yuan[1], Bruce A. Linquist[2], Lloyd T. Wilson[3], Kenneth G. Cassman[4], Alexander M. Stuart[5], Valerien Pede[5], Berta Miro[5], Kazuki Saito[6], Nurwulan Agustiani[7], Vina Eka Aristya[8], Leonardus Y. Krisnadi[9], Alencar Junior Zanon[10], Alexandre Bryan Heinemann[11], Gonzalo Carracelas[12], Nataraja Subash[13], Pothula S. Brahmanand[14], Tao Li[15], Shaobing Peng[1]✉ & Patricio Grassini[4]✉

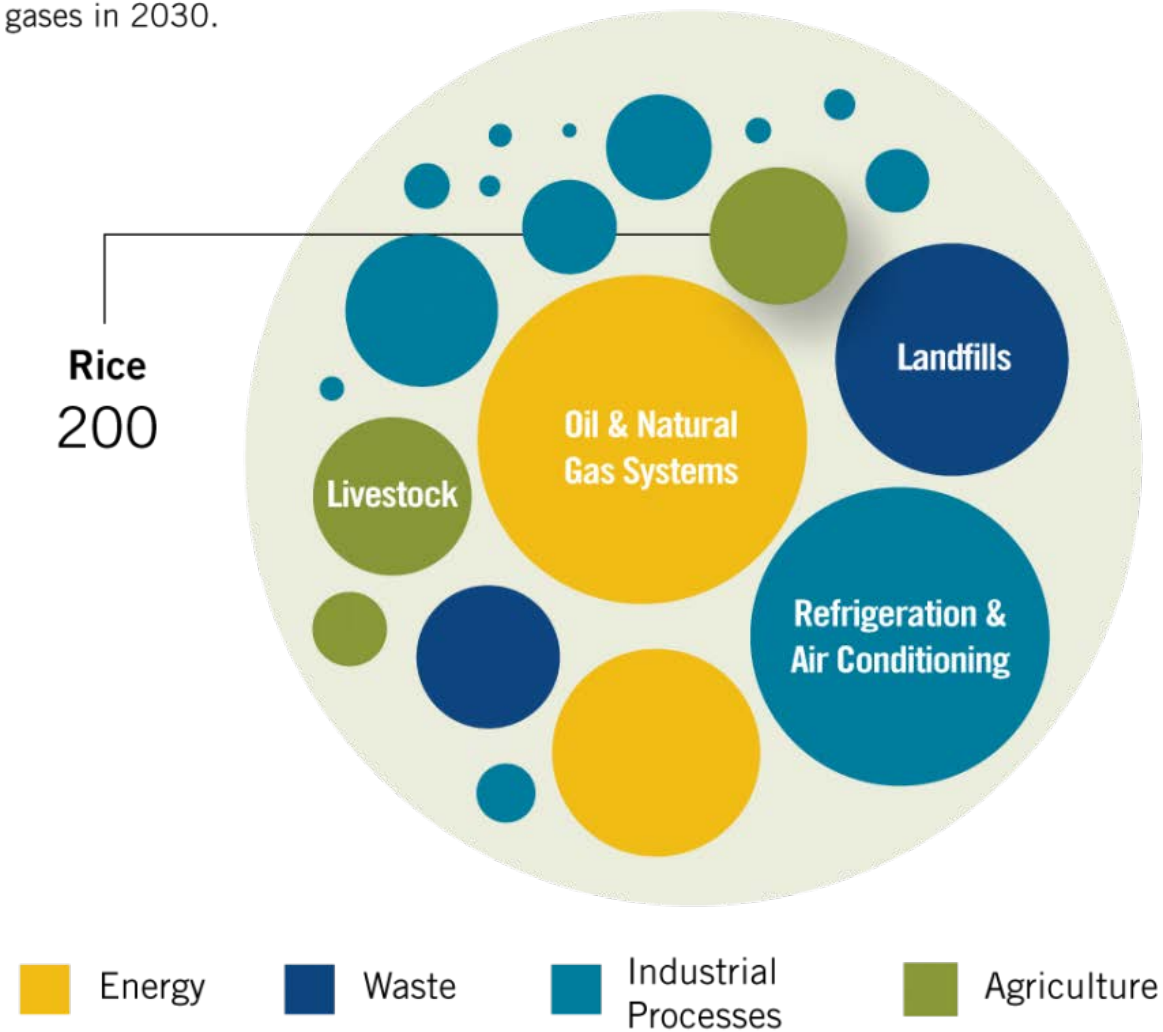
- 30% irrigation
- 14% fertilizers
- 10% pesticides

- 30% methane emission
- 10% nitrous oxide emission
- Third crop in labor requirement

Alliance Bioversity International CIAT

CH_4 and N_2O Emissions from Rice Cultivation: Emissions Reduction Potential in 2030

Assuming full implementation of current technology, emissions in the rice cultivation sector could be reduced by up to 200 $MtCO_2e$ in 2030. This accounts for 4% of the 4,615 $MtCO_2e$ in global reduction potential for non-CO_2 greenhouse gases in 2030.



U.S. Environmental Protection Agency (2014). *Global Mitigation of Non-CO_2 Greenhouse Gases: 2010-2030.*

How to diminish the greenhouse gases emissions in Rice crop

Practices

- Minimum tillage
- Rotation
- Better water management (AWD)
- NUE , low N input
- Carbon sequestration
- Others …

Genetics

- Different varieties have different emission rate
- Yield and emission…
- Traits that are correlated with a higher amount of emissions (aerenchyma)

?

Do different varieties have different rates of emissions?

Are there any traits from rice correlated to CH4 emissions

Methodology

1. Field experiment set up at the CIAT campus, in Colombia

2. Randomized complete block design

3. Four replicates

4. 4 rice genotypes: 2 hybrids 1 breeding line, 1 variety

Fertilization
Hybrids - 200 kg N ha-1
Varieties - 180 kg N ha-1

GHG monitoring

- Closed static chamber technique.
- Gas samples were collected 25 times during the rice-growing season

Rice traits

- Baseline soil chemical properties
- Leaf area index
- Aboveground dry biomass
- Plant height
- Tillers
- Root properties (length, volume, surface area, biomass)

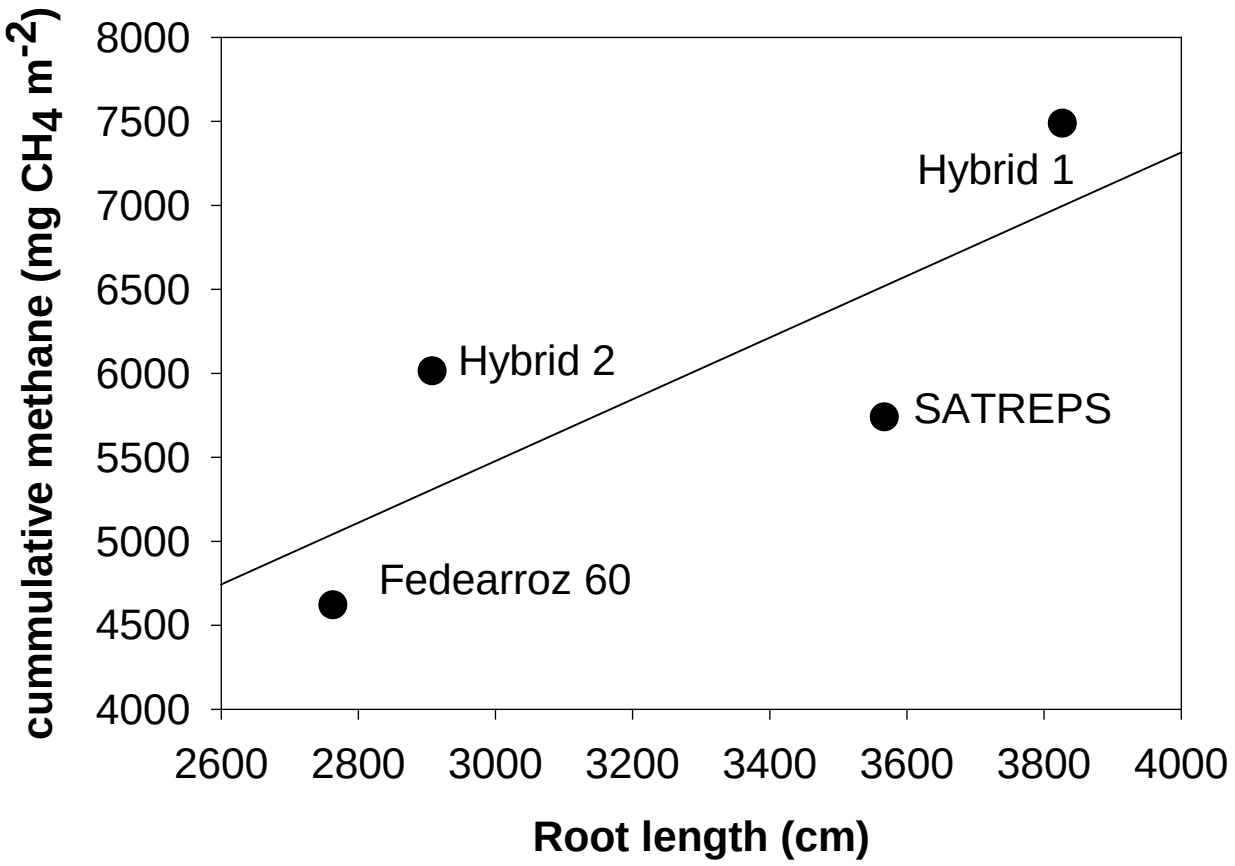
*Test of correlation between the trait and fluxes of emissions

Results

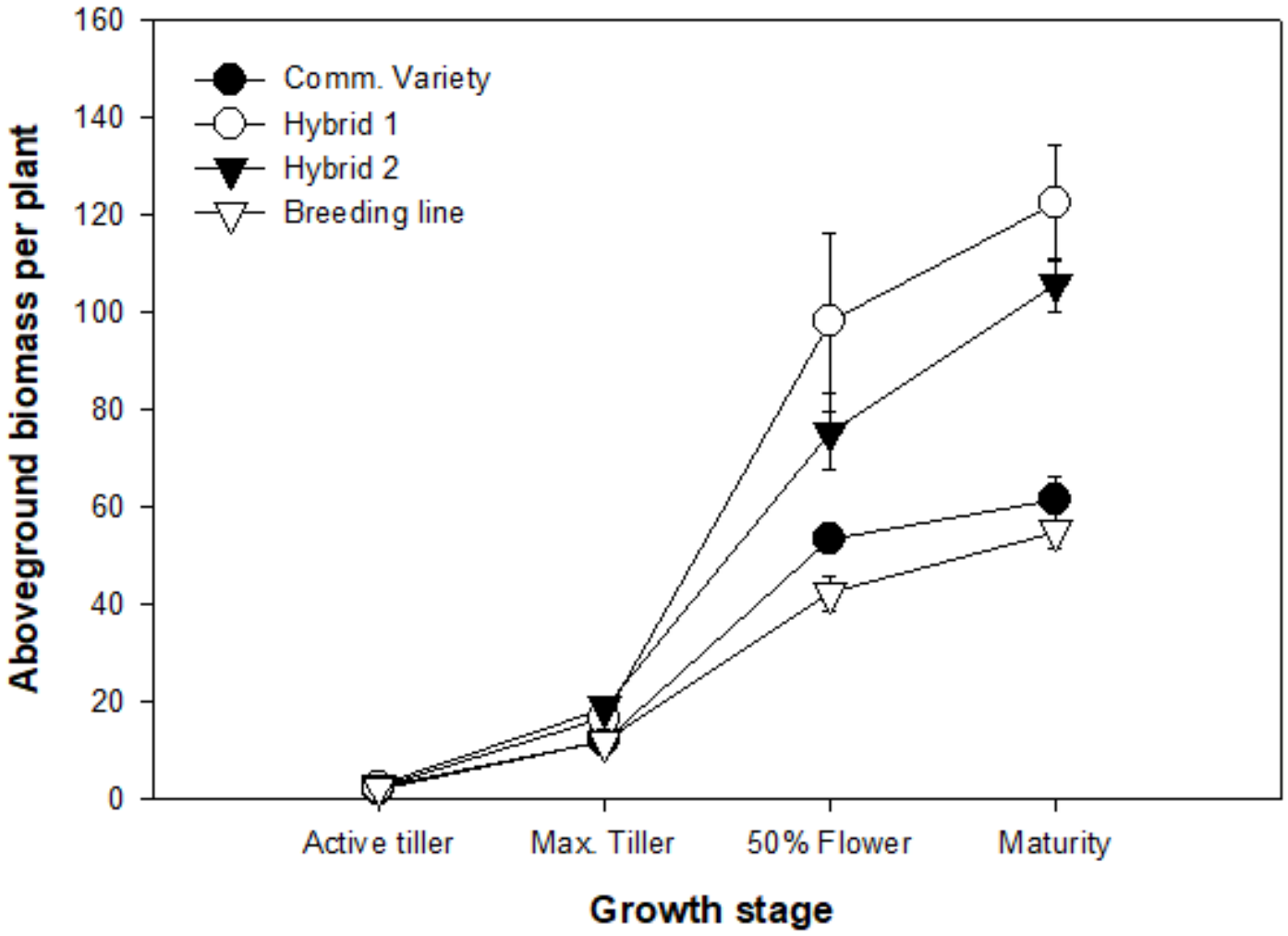
Root traits

Genotype	Root length at physiological maturity (cm)	Root volume at physiological maturity (cm^3)	Root surface area at physiological maturity (cm^2)
Commercial variety	2763^{a}	6.4^{a}	465^{a}
Breeding line	3567^{a}	8.4^{ab}	607^{ab}
Hybrid 1	2908^{a}	8.1^{a}	540^{a}
Hybrid 2	3826^{b}	11.0^{b}	725^{b}

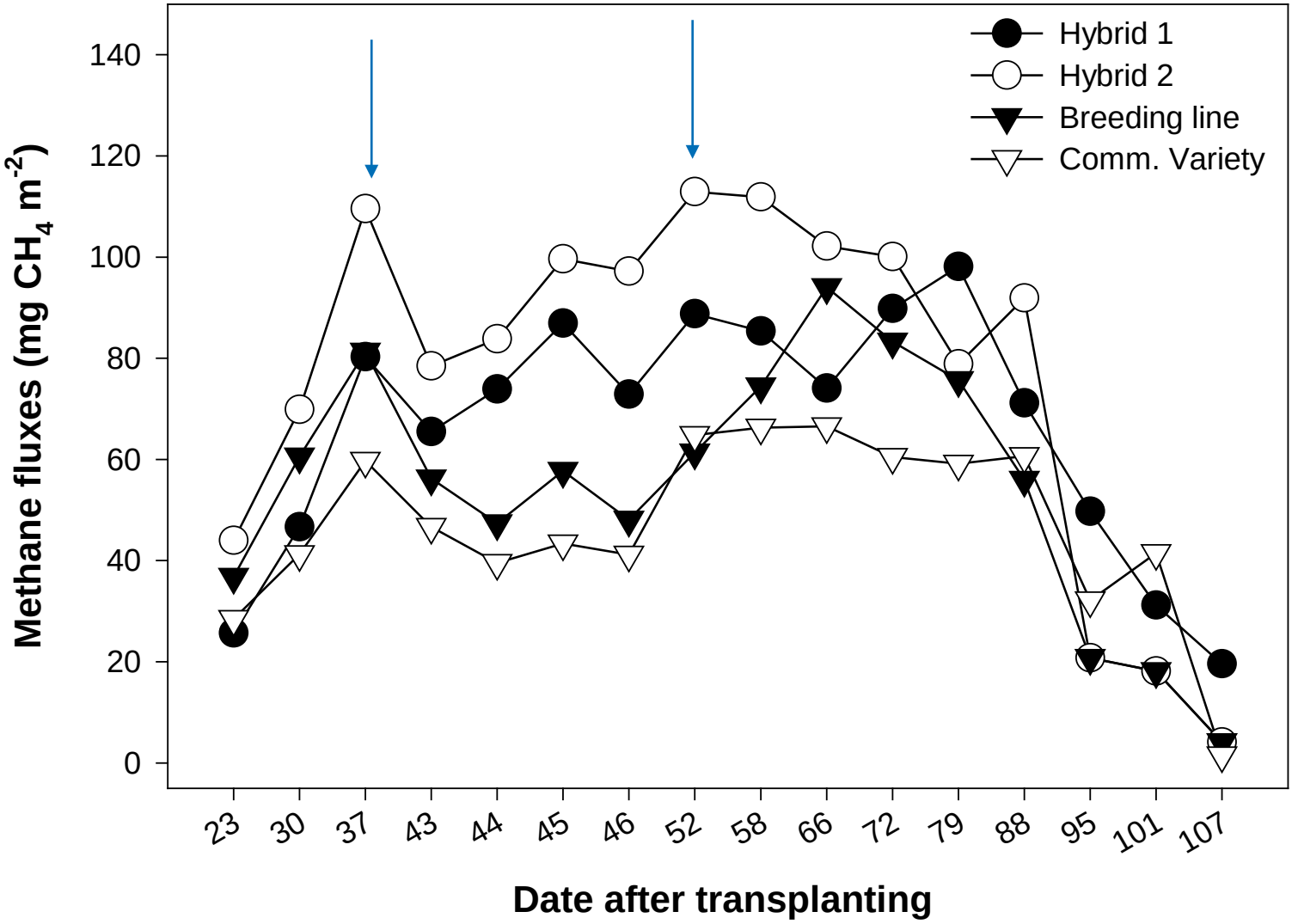
Root length vs methane emissions



Biomass


Comm. Variety
Hybrid 1
Hybrid 2
Breeding line
Aboveground biomass per plant
160
140
120
100
80
60
40
20
0
Active tiller
Max. Tiller
50% Flower
Maturity
Growth stage

Emissions


Hybrid 1
Hybrid 2
Breeding line
Comm. Variety
Methane fluxes (mg CH_4 m^{-2})
0
20
40
60
80
100
120
140
23
30
37
43
44
45
46
52
58
66
72
79
88
95
101
107
Date after transplanting

Emission and yield

Genotype	Cumulative methane (mg CH_4 m^{-2})	Emission intensityintensity (mg CH_4 kg^{-1} dry matter)	Grain yield (kg ha^{-1})	Index (mg CH_4 kg^{-1}
Commercial variety	4338a	0.73a	6333a	**6,84**
Breeding line	4482a	0.75a	5801a	7,73
Hybrid 1	5761b	0.65a	8607b	**6,69**
Hybrid 2	7068c	1.19a	8647b	8,17

Preliminary findings

- CH_4 emissions follow the same trend as plant biomass accumulation
- Varieties generally showed lower CH_4 emissions compared to hybrids
- Yet, hybrids yielded more that varieties and at least one process less emission per Kg of produced rice
- It appears that not all rice is created equal and the potential to exploit genotypic variation to achieve low emitting rice exists

Rice program at CIAT

We are a multidisciplinary team aligned to:

Ensure calorie intake for the world rural and urban communities, with a healthier, abundant and nutritious rice with **sustainable and climate friendly practices**. Contributing to a decent work and **economic growth** through the reinforcement of rice value chain.

To achieve sustainability, we need to reduce the emissions per Kg of paddy rice, with agricultural practices and **genetics**

Alliance Bioversity International CIAT

Alliance

Bioversity International

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

Thank you!

Author

Position

Email

CGIAR