Addressing phosphorus deficiency in rice in Sub-Saharan Africa

Dr. Tovohery RAKOTOSON
Postdoctoral Researcher
University of Antananarivo

Reason for the Award

The awardee quantified the amount of solubilized phosphorus in the soil when compost is applied in various soils, showing that application of compost to phosphorus-deficient paddy fields can greatly increase the phosphorus uptake of paddy rice and its yield. This study is highly evaluated as a problem-solving study based on the needs of the field in Africa. The results of this research could reduce the amount of purchased fertilizer while maintaining the yield.

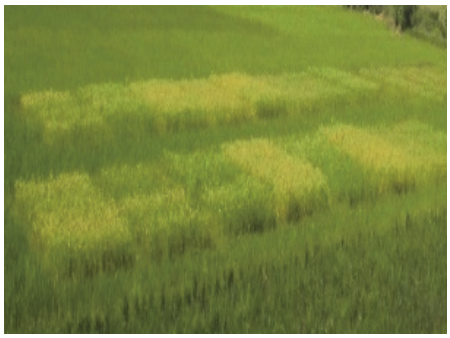
Outline of Research Achievement

Phosphorus (P) deficiency is a major limiting factor for rice production in Sub-Saharan Africa (SSA). Our study identified that the application of organic materials such as rice straw and farmyard manure (FYM) increases P availability through microbial-mediated reduction of iron (Fe) oxides with subsequent solubilization of Fe-bound P in soils increasing P uptake and biomass of rice. The isotope dilution technique confirmed that FYM application enabled the use of otherwise insoluble P pools in soils and enhanced uptake of rice plants. FYM application against P deficiency was also demonstrated in farmers' lowlands in Madagascar with greater impact in soils with low pH and low carbon contents. An extensive survey identified that soil P fractions in the central highlands of Madagascar are mostly insoluble forms bound to Fe and aluminum (Al) oxides. These findings should promote the locally available organic resources to more efficiently utilize insoluble P pools in soils and enhance lowland rice production in the region. We also identified that a micro-dose of NPK fertilizer applied to the nursery bed produced more vigorous seedlings, resulting in higher grain yields and higher profitability compared to current farmers' fertilization practice for lowland rice production in Madagascar. Our findings are relevant to integrated fertilization management using locally available organic resources and small amounts of mineral fertilizer to address the typical P-deficient soils in SSA and efficiently increase the lowland rice production.

NURSERY PLOTS

P microdosing with different organic and mineral sources

FIELD PLOTS



Seedlings from nursery plots grown in non-fertilized or combination of N, P, and K fertilized plots

Main Publications:

(1) **Rakotoson, T.,** Tsujimoto, Y., & Nishigaki, T. (2022). Phosphorus management strategies to increase lowland rice yields in sub-Saharan Africa: A review. *Field Crops Research*, 275, 108370. https://doi.org/10.1016/j.fcr.2021.108370

(2) **Rakotoson, T.,** Rinasoa, S., Andriantsiorimanana, A., Razafimanantsoa, M.-P., Razafimbelo, T., Rabeharisoa, L., Tsujimoto, Y., & Wissuwa, M. (2020). Effects of fertilizer micro-dosing in nursery on rice productivity in Madagascar. *Plant Production Science*, 24(2), 170-179. https://doi.org/10.1080/1343943X.2020.1828947

(3) **Rakotoson, T.,** & Tsujimoto, Y. (2020). Pronounced effect of farmyard manure application on P availability to rice for paddy soils with low total C and low pH in the central highlands of Madagascar. *Plant Production Science*, 23(3), 314–321. https://doi.org/10.1080/1343943X.2020.1740601

Genetic improvement of global wheat, including progress for enhancing insect resistance

Dr. Leonardo CRESPO HERRERA

Wheat breeder-Scientist

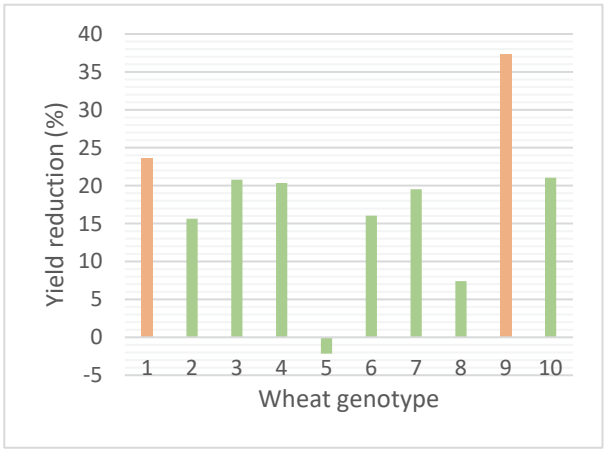
International Maize and Wheat Improvement Center (CIMMYT)

Reason for the Award

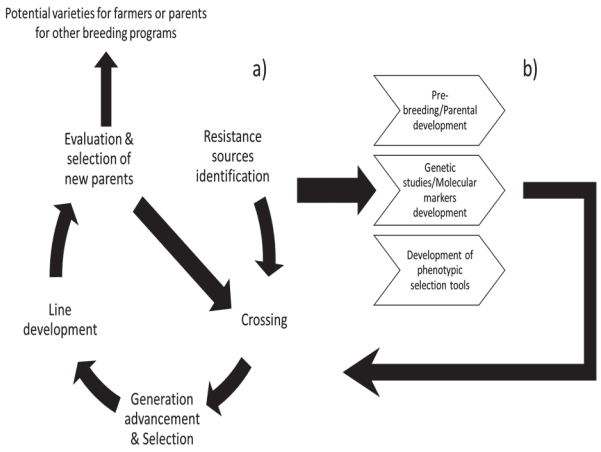
The awardee developed an efficient method of breeding wheat lines with aphid resistance through the identification of insect resistance genes in wheat and the development of genetic markers. This study has been highly evaluated for developing lineages that have been distributed worldwide for use in wheat breeding, and the methods of this study have been applied to develop varieties with resistance mechanisms against various kinds of insects, not only aphids.

Outline of Research Achievement

Breeding insect-resistant wheat varieties is challenging because it requires the availability of genetic diversity and selection and evaluation tools to make genetic progress. This work is an end-to-end established process for insect resistance breeding in wheat, from trait discovery to breeding and germplasm sharing within an international network for wheat improvement, for the benefit of other breeding programs and farmers in developing countries. This work resulted in the identification of novel resistance sources and genomic regions conferring the resistance to aphids, the usage of high-throughput phenotyping tools to assist the evaluation of breeding lines, and the evaluation of yield protection conferred by the resistance sources and its integration in breeding pipelines.



Grain yield protection of aphid resistance



Integration with breeding

Main Publications:

(1) **Crespo Herrera, Leonardo**; Singh, Ravi Prakash; Reynolds, Matthew; Huerta-Espino, Julio (2019) Genetics of Greenbug Resistance in Synthetic Hexaploid Wheat Derived Germplasm. *Front. Plant Sci.* 10.

(2) **Crespo Herrera, Leonardo**; Singh, Ravi Prakash; Sabraoui, Abdelhadi; El-Bouhssini, Mustapha (2019) Resistance to insect pests in wheat—rye and Aegilops speltoides Tausch translocation and substitution lines. *Euphytica* 215, 123.

(3) **Crespo Herrera, Leonardo**; Akhunov, E.; Garkava-Gustavsson, Larisa; Jordan, Katherine; Smith, Michael; Singh, Ravi Prakash; Åhman, Inger (2014) Mapping resistance to the bird cherry-oat aphid and the greenbug in wheat using sequence-based genotyping. *Theor. Appl. Genet.* 127, 1963–1973.

The Value of Agricultural Waste: Cellulose as a Building Block for Materials

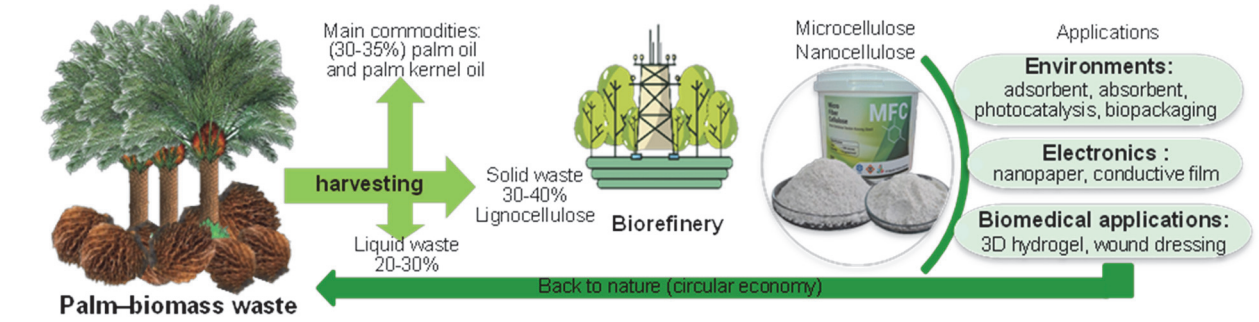
Dr. Athanasia Amanda SEPTEVANI
Senior Researcher
National Research and Innovation Agency (BRIN)

Reason for the Award

The awardee established a simple, low-cost, and environmentally friendly process for producing high-purity cellulose from empty fruit bunches of discarded oil palm. Since the oil palm industry plays an important role in the Indonesian economy, the prevalence and practical application of the processing method developed in this study will lead to the effective use of oil palm waste in the future. This research is highly recognized for its potential to reduce the environmental impact and improve the management of producers.

Outline of Research Achievement

Indonesia is one of the largest producers of palm oil in the world and thus is of importance to the economy. However, a huge amount of solid residues is generated every year with lack of utilization and mostly used for fertilizer, while the rest is simply disposed or burnt causing serious environmental problems. To address this issue while giving added value to this agricultural waste, this research offers the answer as a potential development of biomass valorization into advanced cellulose materials with unique characteristics, enabling its use in various fields including but not limited to environmental, electronic, and biomedical applications.



Main Publications and Patent:

(1) **Septevani, A.,** Burhani, D., Sampora, Y., Indriyati, Shobih, S., Septa Rosa, E., Sondari, D., Margyaningsih, N., Septiyani, M., Yurid, F., Handayani, A. (2022) A systematic study on the fabrication of transparent nanopaper based on controlled cellulose nanostructure from oil palm empty fruit bunch. *Journal of Polymers and the Environment* 30, 3901–3913.

(2) **Septevani, A.,** Rifathin A., Sari, A., Sampora, Y., Ariani, G., Sudiyarmanto, and Sondari, D. (2020) Oil palm empty fruit bunch-based nanocellulose as a super-adsorbent for water remediation. *Carbohydrate Polymers* 229, 115433.

(3) **Septevani, A.,** Sudirman, Sampora, Y., Burhani, D., Sudiyarmanto, Septiyani, M., Devy, Y., Sondari, D., Triwulandari, E., Ghozali, M., Meilana, Y., Haryono, A. "Nanoselulosa Dari Limbah Biomassa Tandan Kosong Kelapa Sawit Dan Proses Pembuatannya – English: Nanocellulose from biomass waste of empty fruit bunches, and its production of thereof", Granted Patent: IDP000082142 on 22 July 2022.