Mangrove forest blue carbon research for effective nature-based solutions to mitigate climate change in Asia Pacific region

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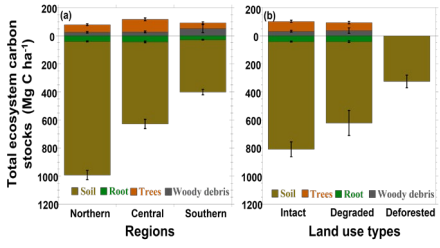
Reason for the Award

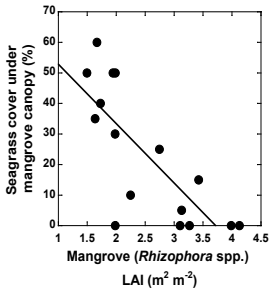
The awardee has engaged in research on the impact of climate change on the dynamics of coastal sediments and the blue carbon cycle using remote sensing and other techniques and developed a quantitative evaluation method for the environmental conservation function of mangrove forests. The research shows that blue carbon plays important roles to manage problems such as rising sea levels due to climate change. We highly evaluated his results because they were disseminated widely and show successful performances in international research cooperation.

Outline of Research Achievement

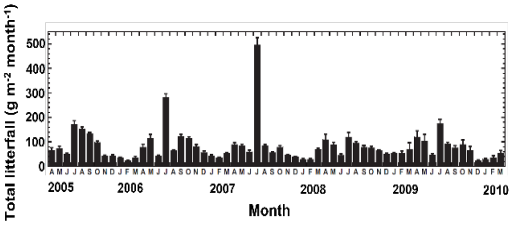
Mangrove forests can help reduce global C emissions and act as a nature-based solution. A nationwide C inventory across different land use types and environmental settings is needed to understand their role in climate change mitigation. Mangrove forests are being deforested or degraded, resulting in significant losses of reserved blue carbon. While the conservation of remaining mangrove forests is the most effective strategy for climate change mitigation and adaptation, it appears that restoration results in mangroves that can continue to combat climate change for 25–30 years. However, the purpose of mangrove restoration should be clear, and efforts should be focused on formerly deforested or degraded areas rather than other ecologically important ecosystems. Mangroves can grow to some extent on seagrass beds, though mangrove planting in these areas could eventually lead to seagrass loss. A long-term ecological monitoring program is needed to understand the combined impact of anthropogenic and global climate change (sea level rise, typhoons etc.) on mangrove forests to better conserve and manage nature-based solutions.



Nationwide mangrove carbon stock inventory across land use types and regions in Cambodia



Seagrass cover reduced under restored mangrove canopy



Long-term monitoring of total litterfall for mangrove

Main Publications:

(1) The impacts of degradation, deforestation and restoration on mangrove ecosystem carbon stocks across Cambodia. Science of the Total Environment, 706, 135416 (2020)

(2) Growth performance and structure of a mangrove afforestation project on a former seagrass bed, Mindanao Island, Philippines. *Hydrobiologia*, 803, 359-371 (2017)

(3) Litterfall dynamics in an overcrowded mangrove Kandelia obovata (S., L.) Yong stand over five years. Estuarine, Coastal and Shelf Science, 98, 31-41 (2012)

Establishment of a novel diagnostic test for Bovine leukaemia virus infection using direct filter PCR

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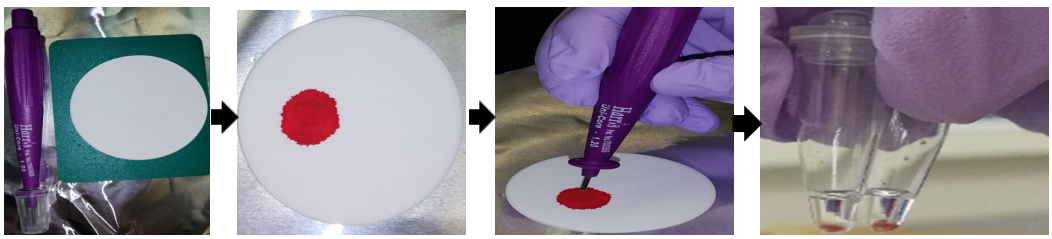
Reason for the Award

The awardee has been engaged in the development of a testing method for Bovine leukaemia virus using direct filter PCR method. Using blood-spotted filter paper as a PCR template enabled us to perform diagnosis more accurately, inexpensively, rapidly, and simply than conventional methods. This test method is considered particularly useful in developing countries where equipment and human resources are scarce. It is anticipated that this method will be put to practical applications and spread in the future, and the research was highly valued for its contribution to developing countries.

Outline of Research Achievement

Enzootic bovine leucosis (EBL) is a neoplastic disease of cattle caused by Bovine leukaemia virus (BLV). EBL causes great economic losses, so a fast and reliable diagnostic method is critical for understanding the status of BLV. This will allow us to control BLV infections efficiently and mitigate economic losses. In this study, we established a direct diagnostic test for BLV using dried blood-spotted filter papers without sample pre-treatment. The study was based on 159 clinical blood specimens collected in EDTA from one farm in Kyushu, Japan. The blood-spotted filter papers were used as the template for direct filter PCR. When an ELISA was used as the diagnostic gold standard, the sensitivity and specificity of the direct filter PCR were 90.1% and 97.5%, respectively. The reliability of the direct filter PCR was evaluated with real-time PCR, the Kappa value was 0.97, indicating a consistently high degree of agreement. The dried blood samples spotted onto filter papers were stable for at least 10 days at room temperature, even when the samples were from cattle with a low BLV proviral load. Direct filter PCR is a rapid, easy, reliable and cost-effective diagnostic test that directly detects the BLV proviral genome in clinical blood specimens without DNA extraction. Moreover, it simplifies the collection, transportation and storage procedures for clinical blood specimens.

Direct filter PCR technique



1 mm unicore cutting pen and 55 mm filter paper

Blood-spotted filter paper (sample)

Cutting of blood-spotted filter paper

1 mm cut piece template for PCR

Main Publications:

(1) **Daous HE**, Mitoma S, Elhanafy E, Thi Nguyen H, Thi Mai N, Notsu K, Kaneko C, Norimine J, Sekiguchi S. Relationship between Allelic Heterozygosity in *BoLA-DRB3* and Proviral Loads in Bovine Leukemia Virus-Infected Cattle. Animals 2021,11, 647 (2021).

(2) **Daous HE**, Mitoma S, Elhanafy E, Thi Nguyen H, Thi Mai N, Hara A, Duangtathip K, Takezaki Y, Kaneko C, Norimine J, Sekiguchi S. Establishment of a novel diagnostic test for *Bovine leukaemia virus* infection using direct filter PCR. *Transbound. Emerg. Dis*. 2020; 00:1–6 (2020).

(3) Mai TN, Bui TP, Huynh TML, Sasaki Y, Mitoma S, **Daous HE**, Fahkrajang W, Norimine J and Sekiguchi S. Evaluating the Risk Factors for Porcine Epidemic Diarrhea Virus Infection in an Endemic Area of Vietnam. *Front. Vet. Sci*. 7:433 (2020).

Nitrogen nutrition of cocoa (*Theobroma cacao* L.) in intercropping systems with gliricidia (*Gliricidia sepium* (Jacq.) Kunth ex Walp.)

Dr. James Seutra KABA

Lecturer

Kwame Nkrumah University of Science and Technology

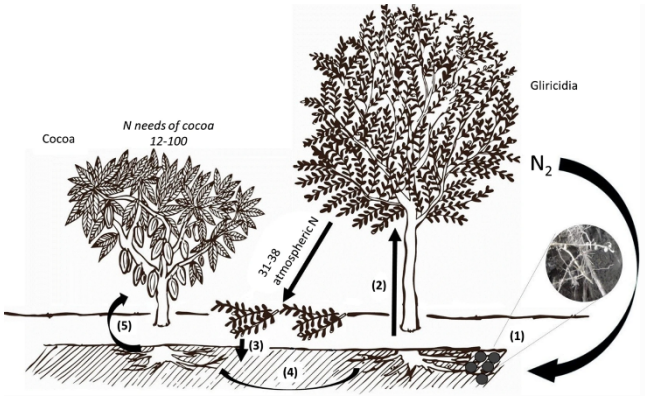
Reason for the Award

The awardee has engaged in research on nitrogen cycling in cocoa agroforest systems in tropical soils and demonstrated the optimal intercropping method with Gliricidia. This study also provided data on nitrogen cycling, which was difficult to estimate in the past, and contributed to the practice of intercropping among small-scale cocoa farmers. The proposed intercropping method is expected to be useful for improving the management and livelihood of small-scale cocoa farmers in Ghana and other tropical regions, and the research was highly evaluated for its high potential for dissemination.

Outline of Research Achievement

The cocoa sector employs 25% to 30% of Ghana's population. The sector is, however, saddled with the depletion of soil nitrogen (N). The net effect is low yields (0.45 Mg ha^{-1}) compared to achievable yields of 1.0 Mg ha^{-1} (Yamoah et al., 2019). Soil N deficiency, which causes stunted cocoa growth, fruit abortion, and poor pod yields, could be prevented by the supply of mineral N fertilizers, but these are often unaffordable for smallholder farmers, who represent the majority (70%) of cocoa farmers in Ghana. N_2-fixing legume trees, if properly managed, could provide an alternative to mineral N fertilizers as a means for enhancing soil N availability. Kinkema et al. (2006) indicated that Gliricidia is capable of forming a symbiotic association with N_2-fixing rhizobia and it produces high-quality biomass.

Molecular characterization showed the presence of *Rhizobium tropici* and *R. etli* in gliricidia root nodules. The N derived from the atmosphere ranged between 22% to 50% of total shoot N of Gliricidia trees. The estimated annually produced shoots of gliricidia contained 31 to 38 kg N ha^{-1}. Thus, it could diminish the need for N fertilizers for cocoa. This also has implications for agroforestry waste management and nutrient recycling.



Schematic of the transfer of the atmospheric N (Ndfa) fixed by *Rhizobium tropici* and *R. etli* associated with gliricidia root nodules to cocoa trees in intercropping systems through pruned shoots left on top of the soil as green manure.

(1) Symbiotic N fixation by root nodules; (2) Uptake of Ndfa from gliricidia trees and allocation to shoots; (3) Gliricidia shoots pruned and left at the soil surface decompose and release Ndfa that enters the soil; (4) Potential direct Ndfa transfer from gliricidia roots to cocoa roots through mycorrhizal network; (5) Ndfa uptake by cocoa roots. Data are in kg N ha^{-1}.

Main Publications:

(1) **Kaba JS**, Zerbe S, Agnolucci M, Scandellari F, Abunyewa AA, Giovannetti M, Tagliavini M (2019). Atmospheric nitrogen fixation by gliricidia trees (*Gliricidia sepium* (Jacq.) Kunth ex Walp.) intercropped with cocoa (*Theobroma cacao* L.) in agroforestry systems. *Plant Soil* 435:323-336.

(2) **Kaba JS** and Abunyewa AA (2021). New aboveground biomass and nitrogen yield in different ages of gliricidia (*Gliricidia sepium* Jacq.) trees under different pruning intensities in moist semi-deciduous forest zone of Ghana. *Agroforest System* 95:835–842.

(3) **Kaba JS**, Yamoah FA and Acquaye A (2021). Towards sustainable agroforestry management: Harnessing the nutritional soil value through cocoa mix waste. *Waste Management* 124:264–272.