フレキシブルナノ粒子触媒技術を用いたナノ肥料の開発

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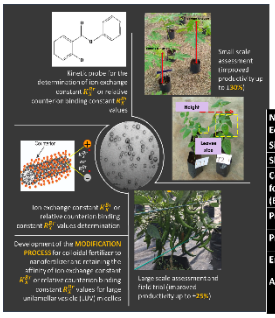
受賞評価のポイント

受賞者は、フレキシブルナノ粒子触媒技術を用いることにより、従来の肥料のコロイド凝集体の大きさをナノサイズに縮小したナノ肥料に変換し、安価に製造することを可能にした。開発したナノ肥料は、葉面散布肥料の特性を改善し、作物の生産性を向上させ施肥量を節約できる特徴を有する。本技術は既に商品化され普及が進められており、資源の有効活用が求められるなか、将来の発展が期待できる研究が評価された。

主な業績

肥料価格は、農家が栽培シーズンに向けて買い付けを開始する際に最も気になる問題である。こうして、フレキシブルナノ粒子触媒技術と呼ばれる、低コストでシンプル、特有かつ環境に優しいナノ肥料製造プロセスが開発され、農業、食品、資材産業に寄与している。本研究では、フレキシブルナノ触媒技術を持続可能な農業のためのターゲット・デリバリー肥料の開発に使用した。界面活性剤分子のナノ次元吸着担体、すなわち栄養分と結合するフレキシブルナノ粒子またはミセルは、葉面散布によって植物系に付着し、植物系へのターゲット・デリバリーによって栄養分を放出する。

現在、この斬新な新しい技術は、特許（MY-188725-A）および企業秘密（TS 2019/35/079）で保護されており、KPG Sdn. Bhd 社によって商品化もされている。また、この技術は、国際的にも広く受け入れられ、実証されており、ドイツのニュルンベルクで開催された国際アイデア・発明・新製品見本市（iENA 2022）で金賞を受賞した。



FERTILIZER PRODUCTION PROCESSES COMPARISON

	Natural fertilizer (compost, gypsum)	Synthetic fertilizer (urea, potash)	Mixed fertilizer (paste fertilizer)	FlexNanoCat
Need Expensive Equipment	NO	YES	YES	NO
Simplicity of Process	YES	NO	NO	YES
Skilled Operator	NO	YES	YES	NO
Cost of Production for 1 Liter (EURO)	Low (€5-6)	High (€12-14)	Medium (€8-10)	Low (€5-6)
Production period	Long	Long	Long	Short
Process Safety Risk	Low	High	Medium	Low
Environmental Issue	Low	High	Medium	Low
Absorptivity by plant	Slow	Medium	Medium	Optimized (controlled-release)

主要論文：

(1) **Khalisanni Khalid**, Muhammad Azri Mohd Noh, Sharifuddin Md. Zain & M. Niyaz Khan (2016) Correlation of kinetic and rheological data for flexible nanoparticle catalysis in the reaction of piperidine with PS-. *Catalysis Letters* 146, 960–967
(2) **Khalisanni Khalid**, Muhammad Azri Mohd Noh, Sharifuddin Md. Zain & M. Niyaz Khan (2017) Determination of relative counterion binding constant to cationic micelles. *Topics in Current Chemistry*, 375(45), 1-18
(3) **Khalisanni Khalid**, Muhammad Azri Mohd Noh, Ibrahim Isah Fagge, Sharifuddin Md. Zain & M. Niyaz Khan (2016) Effects of cationic nanoparticles (CNP) on counterion binding constant(R_X^{Br}) and catalytic constant (k_{cat}) in micellar system. *Journal of Molecular Catalysis A*: Chemical 423, 365–370

Development of Nanofertilizer using Flexible Nanoparticle Catalysis Technology

Dr. Khalisanni KHALID
Senior Research Officer
Malaysian Agricultural Research and Development Institute (MARDI)

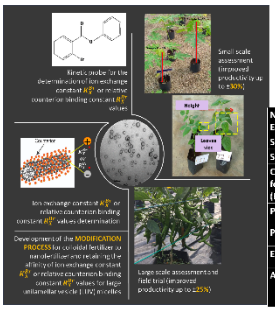
Reason for the Award

The awardee made it possible to produce nanofertilizers inexpensively by using flexible nanoparticle catalysis technology, which can reduce the size of colloidal aggregates of conventional fertilizers to nano-size. The developed nanofertilizer has features that can enhance the characteristics of foliar application fertilizer, improve crop productivity, and reduce the amount of fertilizer applied. This technology has already been commercialized and popularized, and the research has been evaluated for its potential for future development in the context of the need for effective utilization of resources.

Outline of Research Achievement

Fertilizer prices are the number one issue on farmers' minds as they begin to set up purchases for the growing season. Thus, a low-cost, simple, specific and eco-friendly nanofertilizer production process called flexible nanoparticle catalysis technology has been developed to nourish the agriculture, food, and commodity industries. In the present research, the flexible nanoparticle catalysis technology is used to develop the targeted delivery fertilizer for sustainable agriculture. The nano-dimensional adsorbent carrier of surfactant molecules, namely a flexible nanoparticle or a micelle that binds to the nutrients, attaches to the plant system through foliar applications and releases nutrients through targeted delivery to the plant system.

The present innovation has been protected under patent granted (MY-188725-A) and trade secret (TS 2019/ 35/ 079) and was also commercialized by KPG Sdn. Bhd. The technology also won the Gold Medal at the International Trade Fair of Ideas, Inventions and New Products (iENA 2022) in Nuremberg, Germany.



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インドの半乾燥半湿潤地域における環境に優しい土壌健康管理戦略の開発と評価

アビジット・ゴーシュ

研究員

インド農業研究委員会 インド草原・飼料研究所

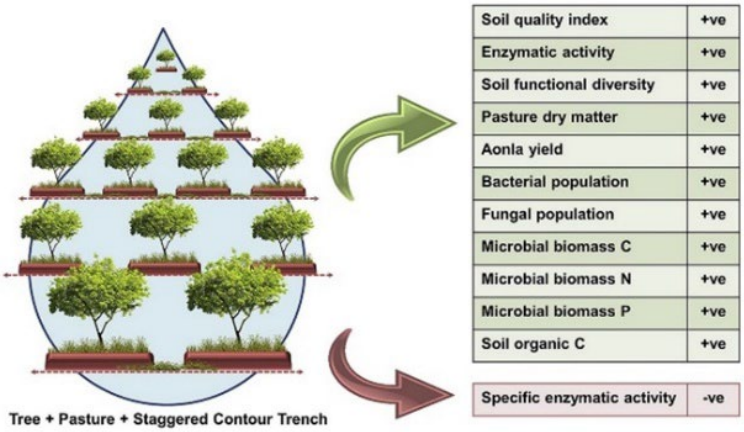
受賞評価のポイント

受賞者は、インドにおける土壌中の有機炭素の分解の温度感受性と熱水感受性を解析するとともに深部土壌の炭素隔離能力を推定し、土壌への炭素貯留に気候変動が与える影響について考察した。また、インドの深刻な大気汚染の原因の一つとされる大量の稲わらの焼却を防止するため、稲わらを天然のケイ素源として利用し、在来の土壌リンの可溶化につなげるなど、農業生産と環境保全の両立に資する取組を行った。広い視野で、現地の農法に基づき持続可能な土地管理を可能とする独創的な研究が評価された。

主な業績

インドは土地劣化という危機的状況に直面している。この土地劣化は、インドの国内総生産を削減しているだけでなく、インド国内の気候変動現象を悪化させている。我々の研究グループは、環境に優しい土壌健康管理戦略が、荒廃した土地を回復させ、土壌の炭素隔離を促進し、地元の人々に収入をもたらす上で極めて重要な役割を果たすことを証明した。また、稲わらを天然のケイ素源として利用し、難溶性の土壌リンを可溶化することで、稲わら焼却による大気汚染を防止した。

ブンデルカンド地方では、土壌水分保全、保全農業、園芸、森林牧草、造林システムなど、インドの半乾燥地や半湿潤地に適した気候変動に強靭な代替土地利用システムが開発された。すなわち、畜産と林業の統合型（silvopastoral systems）におけるイチジクの一種 *Ficus infectoria*-（クワ科）、*Morus alba*-クワ（クワ科）、アカシアの一種 *Acacia nilotica*-（マメ科）および *Leucaena leucocephala*-ギンネム（マメ科）は、表層における土壌有機炭素隔離を改善し、劣化した休耕地よりも約 55%、91%、77%、71%それぞれ高かった。また、ギンネム、マメ科の *Hardwickia binata*-、アカシアによる林業システムは、休耕地に比べて土壌機能がそれぞれ 9.3 倍、5.3 倍、5.1 倍改善した。この土地修復モデルは、インド政府の様々な国土修復計画を通じて普及されている。



主要論文:

(1) **Avijit Ghosh**, Sunil Kumar, M.C. Manna, Amit K. Singh, Poonam Sharma, Abhijit Sarkar, Madhumonti Saha, Ranjan Bhattacharyya, Sukanya Misra, S.S. Biswas, D.R. Biswas, Kamini Gautam, & R.V. Kumar (2019) Long-term *in situ* moisture conservation in horti-pasture system improves biological health of degraded land. *Journal of Environmental Management*, 248, 109339.

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(3) Hansa Baradwal, **Avijit Ghosh**, Awanish Kumar, Prashant Deo Singh, Manjanagouda Siddanagouda Sannagoudar, Safik Ahamad, Pramod Jha, Amit Kumar Singh, Ranjan Bhattacharyya, Madhab Chandra Manna, Sunil Kumar & Ram Vinod Kumar (2022) Ecological restoration of degraded lands with alternate land use systems improves soil functionality in semiarid tropical India. *Land Degradation & Development*, 33(7), 1076-1087.

Development and Evaluation of Ecofriendly Soil Health Management Strategies for Semi-arid and Sub-humid Region of India

Dr. Avijit GHOSH
Scientist
ICAR-Indian Grassland and Fodder Research Institute (IGFRI)

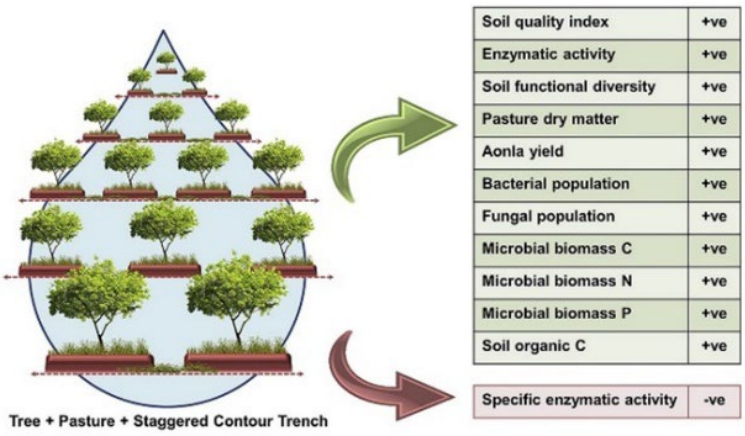
Reason for the Award

The awardee examined the impact of climate change on soil carbon storage by analyzing the thermal and hydrothermal sensitivity of soil organic carbon decomposition in India, and estimating the carbon sequestration capacity of deep soils. In addition, efforts were made to contribute to the coexistence of agricultural production and environmental conservation, such as using rice straw as a natural source of silicon to solubilize native soil phosphorus in order to prevent the incineration of a large amount of rice straw, which is considered to be one of the causes of severe air pollution in India. These research studies have been evaluated for its originality in enabling sustainable land management based on local agricultural methods from a broad perspective.

Outline of Research Achievement

India faces a growing crisis of land degradation. This land degradation is not only whittling away India's gross domestic product but also exacerbating climate change events in the country. Avijit Ghosh and his teammates proved that ecofriendly soil health management strategies have pivotal roles in restoring degraded lands, boosting soil carbon sequestration, and generating income for local people. According to their research, using rice straw as natural silicon source to solubilize recalcitrant soil phosphorus prevented air pollution through incineration.

Climate-resilient alternate land use systems, including soil moisture conservation, conservation agriculture, hortipasture, silvopasture, and silviculture systems suitable for semi-arid and sub-humid India, were developed in the Bundelkhand region. Soil organic carbon accumulation in land eco-restored with *Ficus infectoria*-, *Morus alba*-, *Acacia nilotica*-, and *Leucaena leucocephala*-based silvopastoral systems were approximately 55%, 91%, 77%, and 71% higher than degraded fallow land at surface layers, and the *Leucaena leucocephala*-, *Hardwickia binata*-, and *Acacia nilotica*-based silviculture systems improved the soil functionality by 9.3, 5.3, and 5.1 times over fallow land, respectively. The land restoration models have been disseminated through different national land restoration schemes of the Indian Government.



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アフリカにおける改良作物品種の採用による小規模事業化の改善と貧困削減

マーティン・ポール・ジュニア・タベ-オジョン
准研究員
国際食料政策研究所

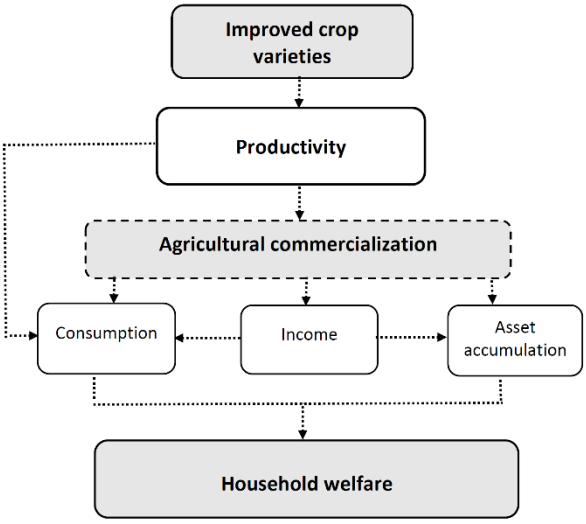
受賞評価のポイント

受賞者は、西アフリカにおける既存の穀物中心の農業活動の改善を目標に、蛋白質含量が多く、かつ窒素固定機能による土壌肥沃の可能性を有する耐乾性マメ科品種の導入が、小規模農家の農業生産や食栄養改善はもとより、商品化を通した営農活動の改善が可能なことを明らかにした。西アフリカの小規模農家における農業イノベーションのためのモデルを提供した開発経済学的研究が評価された。

主な業績

改良作物品種の導入による農業生産性の向上は、経済開発と貧困削減への確かな道筋を示すものであり、特に生産物の商業化を促進するものである。緑の革命から得た知見により、多くの開発途上地域で改良作物品種の開発・普及が進んでいる。これらの改良作物品種は通常、高収量で耐病性があり、市場に関連する形質を備えている。乾燥・半乾燥地帯では一般的に乾季が長くなるため、これらの作物品種の中には、異常気象に耐え、気候変動に強い作物もある。このような改良作物品種は、気候変動対応スマート農業のアプローチにおいて重要な役割を果たすものであり、生産性の向上とそれに伴う福祉への影響、気候ショックへの耐性の強化、温室効果ガスの排出削減という相乗利益をもたらす可能性を秘めている。

我々の研究グループは、カメルーン、エチオピア、ガーナ、マリ、マラウイ、ナイジェリアの様々な生産システムにおいて、農業生産、消費、零細農家の商業化を拡大し、貧困削減につながる 3 つの改良豆類作物（落花生、豆、ひよこ豆）の重要性と可能性を示した。この研究の一部は、生産と市場の両方に関連した特性を持つ改良作物品種の開発におけるジーンバンクの役割にも注目している。これらの研究成果は、様々な科学会議や政策会議で発表され、査読付き学術誌にも掲載されており、2019 年にフィアット・パニス財団の Hans H. Ruthenberg Graduate Award を受賞した。



改良作物品種の導入による
経済開発と貧困削減への道筋

主要論文:

(1) **Tabe-Ojong, M. P.**, Lokossou, J.C., Gebrekidan, B.H. & Affognon, H. (2023) Adoption of climate-resilient groundnut varieties increases agricultural production, consumption and smallholder commercialization in West Africa. *Nature Communication*, 14:5175.
(2) **Tabe-Ojong, M. P.**, Aihounton, B.D.G. & Lokossou, J.C. (2023) Climate-smart Agriculture and Food Security: Cross-country Evidence from West Africa. *Global Environmental Change*, 81(4):102697.
(3) **Tabe-Ojong, M. P.**, Mausch, K., Woldeyohanes, T. & Heckelei, T. (2021) Three hurdles towards commercialization: Integrating subsistence chickpea producers in the market economy. *European Review of Agricultural Economics*, 49(3), 668–695.

Improving Smallholder Commercialization and Reducing Poverty through the Adoption of Improved Crop Varieties in Africa

Dr. Martin Paul Jr. TABE-OJONG

Associate Research Fellow

International Food Policy Research Institute (IFPRI)

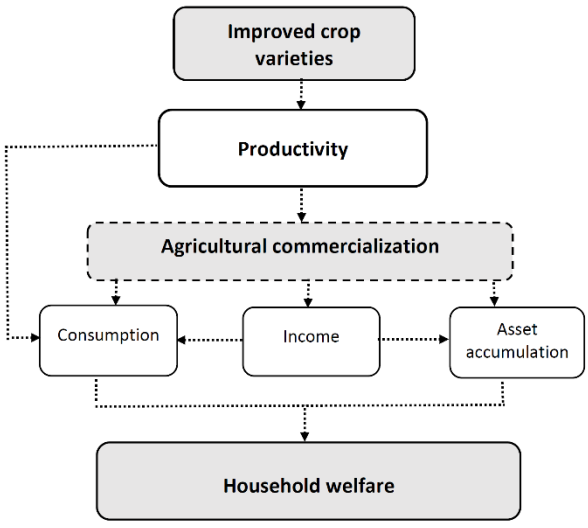
Reason for the Award

The awardee demonstrated that the introduction of drought-tolerant legume varieties with high protein content and potential for soil fertility through nitrogen-fixing functions can improve agricultural production and nutrition for smallholder farmers, as well as their farming activities through commercialization, with the goal of transforming existing grain-based agricultural activities in West Africa. The research has been evaluated as a development economics study that provided a model for agricultural innovation among smallholder farmers in West Africa.

Outline of Research Achievement

Enhancing agricultural productivity through the adoption of improved crop varieties presents a credible pathway to economic development and poverty reduction especially through increased commercialization of production. With insights from the Green Revolution, improved crop varieties are increasingly being developed and disseminated in many developing countries. These improved crop varieties are usually high-yielding and disease-resistant with market-related traits. Given the extended dry seasons common in arid and semi-arid zones, some of these crop varieties are climate-resilient, with the ability to withstand extreme weather events and build climate resilience. These improved crop varieties are a critical part of the climate-smart agriculture (CSA) approach with the potential to offer the triple wins of increasing productivity with ensuing welfare implications, building resilience to climatic shocks and reducing the emission of greenhouse gases.

Martin Paul Jr. Tabe-Ojong and his colleagues have shown the importance and potential of three improved legume crops (groundnuts, beans, and chickpeas) in increasing agricultural production, consumption, and smallholder commercialization with ensuing implications on reducing poverty in various production systems in Cameroon, Ethiopia, Ghana, Mali, Malawi, and Nigeria. Some of this work also looks at the role of genebanks in the development of these improved crop varieties with both production and market-related characteristics. All of this work has been presented at various scientific conferences and policy meetings and have also been published in peer-reviewed journals. Some of this work was earlier awarded the Hans H. Ruthenberg Graduate Award by the Foundation Fiat Panis in 2019.



Adoption of improved crop varieties, commercialization and poverty

Main Publications:

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