DECEMBER 2021

NEWS UPDATE

Dear GSSTAR friends,

Welcome to our final newsletter for the GCRF GlobalSeaweedSTAR programme.

As the programme draws to a close, the team have been incredibly busy hosting their Sharing Best Practice events with many hundreds of stakeholders and launching their national policy briefs. We also hosted the highly successful GSSTAR online Finale in November and I can't thank everyone enough for making this such a wonderful event! I think it is really testament to the tenacity and dedication of the team, that despite all our setbacks, we have been able to create a truly global network of over 200 specialist seaweed researchers, host 8 capacity building workshops and publish over 125 papers, articles and policy briefs to date. A further 15 journal articles are in the pipeline, so please do keep an eye on globalseaweed.org and our media channels.

I cannot praise highly enough the incredible efforts that have been made across the GSSTAR partnership to produce peer-reviewed scientific publications, brochures and videos of a world-class standard, which I hope will provide benefit the seaweed and wider aquaculture community for years to come. This is very much though not the end of GSSTAR, just the end of a chapter. The collaborations (and friendships) that have been formed in this programme, will no doubt be continued through new projects and initiatives, such as the Safe Seaweed Coalition, funded by the Lloyds Register Foundation and the Seaweed Academy, a new training centre funded by UK Government.

Finally, I want to thank you all for your support over the last 4 years. We have been overwhelmed at times by the generosity of our stakeholders, particularly the hundreds of seaweed farmers in our partner countries, who have helped with our work. I would also like to thank our Advisory Board members, who have provided us with their insights into the industry – this has been so appreciated!

So to end, I would just like to wish you a happy, healthy and prosperous 2022!

Liz Cottier-Cook, Lead Scientist

Let's be brief:

Eight ways to safeguard the seaweed industry

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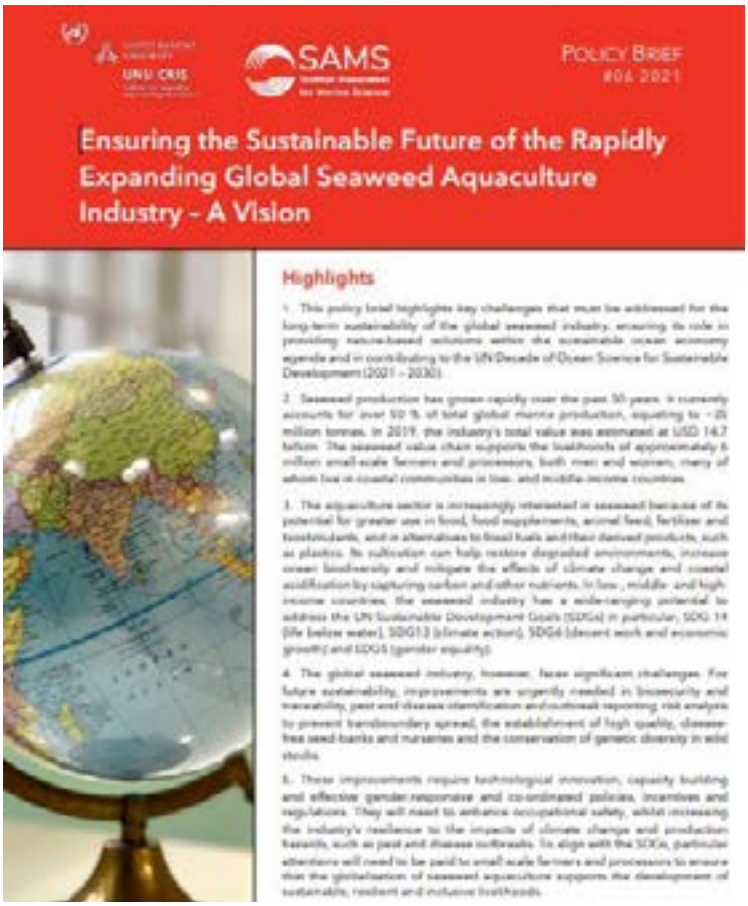


It's goodbye from the GSSTAR team at the conclusion of the finale event

Successful sign-off at grande finale

More than 100 people from across the world attended the virtual GlobalSeaweedSTAR Finale on November 10.

Broadcast on Microsoft Teams, the online event consisted of talks from the programme's leading scientists and early career researchers in Tanzania, the Philippines and Malaysia.

Guests heard summaries of the research conducted over the past four years, which has produced 40 publications to date. GlobalSeaweedSTAR has also supported an additional 15 research projects worldwide, working across 29 countries and with more than 600 seaweed farmers.

The event also saw the launch of the programme's international policy brief, an additional publication to the three national policy briefs for Tanzania, the Philippines and Malaysia. On launching the international policy brief, programme leader Prof Elizabeth Cottier-Cook called on governments to support future research programmes to progress the recommendations in the brief.

Dr Philippe De Lombaerde, Director of programme partner the United Nations University Institute on Comparative Regional Integration Studies (UNU-CRIS), added: "I hope this policy brief will inspire policy makers and I thank all those who contributed to this very interesting publication."

A specially commissioned programme video by SAMS filmmaker Andy Crabb was played at the conclusion of the online event.

View the video here: https://youtu.be/KiOn1AJs6Tk

Philippines partner launches new seaweed lab

GlobalSeaweedSTAR partner, the University of the Philippines Visayas officially opened its new seaweed laboratory, which has been made possible through the university's involvement in the UKRI-funded programme.

The opening took place on December 10 during an online event, broadcast through the Zoom video conferencing platform, and was led by GlobalSeaweedSTAR's Philippines leader Dr Anicia Hurtado.

During the online event, the team also launched a new national policy brief, outlining recommendations for the future sustainability of the islands' seaweed industry.

Speakers at the event included: Dr Danilo L. Concepcion, President, University of the Philippines, Dr. Clement C. Camposano, Chancellor, University of the Philippines Visayas, and Usec. Cheryl Marie Natividad-Caballero, Undersecretary of Agri-Industrialization and Fisheries, Department of Agriculture, Philippines.

GlobalSeaweedSTAR early career researcher Jonalyn Mateo chaired the event.

Seaweed industry must adapt or risk long-term survival

A GSSTAR international policy brief launched in November has warned that the multi-billion-dollar seaweed farming industry – which has overseen rapid growth in recent years – must balance economic profitability with environment, human and organism health to ensure its long-term survival.

Seaweed cultivation is the most rapidly expanding sector in aquaculture production, accounting for more than 50 per cent of total global marine production, equating to around 34.7 million tonnes. Rapid growth in the past 50 years meant the industry reached a value of USD 14.7 billion in 2019. The industry supports the livelihoods of over 6 million small-scale farmers and processors, many of whom are women, in predominantly low and middle-income countries.

Seaweed cultivation is now receiving increased interest from higher income counties as a nature-based solution to economic development, contributing greatly to the UN Sustainable Development Goals (SDGs) and the UN Decade of Ocean Science for Sustainable Development (2021 – 2030).

Seaweed is already widely used in food, cosmetic, pharmaceutical and agriculture industries and has potential as a biofuel. Seaweed farming increases and restores biodiversity by providing habitats for marine creatures and can help to mitigate climate change through carbon capture and methane emission reduction.

There is also a growing commercial demand for higher value seaweed-derived products, such as food ingredients, medical treatments and a specialist agar used as a laboratory medium for COVID-19 testing.

The rapid expansion of the industry though has been in tandem with increasing pressures from warming seas caused by climate change and an over-reliance on certain species, which has seen the industry ravaged by pests and diseases.

The policy brief's lead author and GlobalSeaweedSTAR programme leader Prof Elizabeth Cottier-Cook (Scottish Association for Marine Science) said: "Coastal communities in low to middle income countries have come to rely on seaweed farming for their livelihoods, but we are already seeing the detrimental impacts of climate change and a lack of biosecurity protocols on this industry.

"Warming seas have made coastal waters uninhabitable for some species, while an over-reliance on a few species of seaweed and the widespread importing of non-native stock has allowed pests and disease to spread through entire farms.

"Our policy brief recognises the importance and the potential of this industry in helping to alleviate poverty in developing nations and in meeting the UN Sustainable Development Goals."

The policy brief, which brings together 37 experts from 30 institutions and 18 countries, was launched in partnership with the United Nations University Institute on Comparative Regional Integration Studies (UNU-CRIS). The brief outlines eight recommendations. View the policy brief, with full recommendations at: https://cris.unu.edu/gsstarpolicybrief

Recommendations (summary):

1. Develop clear international policies and regulations.
2. Develop regional and national capacity building initiatives.
3. Develop regional and national seed stocks and biosecure nurseries.
4. Maintain the genetic diversity in wild stocks by conserving wild populations.
5. Advance assessment tools for balancing associated environmental risks with potential benefits of seaweed production.
6. Incentivise the integration of seaweed with other fed-aquaculture species and with other maritime activities.
7. Channel support for long-term investment in promoting the beneficial aspects of the industry.
8. Establish a network of Regional Seaweed Research Networks.

ECRs making an impact

Testing the resilience of seaweed farmers in the face of climate change

How resilient is the Tanzanian seaweed industry to the growing number of challenges it faces today?

To contribute to the growing body of knowledge, GSSTAR's Tanzanian team submitted a paper based on the programmme's work package four activities, titled "A resilience lens to explore seaweed farmers' responses to the impacts of climate change in Tanzania".

The publication by early career researcher (ECR) Ivy Matoju, Virginie Le Masson, Valeria Montalescot, Msafiri Ndawala and Flower E. Msuya was submitted to a special issue of the Journal of Applied Phycology.

The paper looks at the resilience of farmers and their coping strategies using the defined resilience capacity categories by Manyena et al (2019).

It finds that while several strategies help farmers maintain their income, the majority of their coping mechanisms only support their resilience in the short-term and that the increasing pressure on marine resources and the lack of regulations for supporting an equitable and sustainable seaweed-based mariculture sector does not bode well for farmers' long-term adaptation to environmental degradation.

The paper also suggests that seaweed farming remains a crucial source of livelihoods for poor communities but does not currently lead to transformative changes in their socio-economic conditions.

Another contribution from Team Tanzania was in the form of the diseases and pests manual, as well as an accompanying booklet for farmers. The booklet was an output of stakeholder feedback on reviewing the manual, initially developed in Swahili. An English version was also produced later.

The manual is titled 'Diseases and pests of cultivated seaweed, *Kappahycus* and *Eucheuma*, in Tanzania' while the booklet is titled 'Booklet on diseases and pests of cultivated seaweed in Tanzania and measures to reduce their occurrence: A simple guide for farmers'.

The publications detail pests and diseases currently hindering seaweed production and outline measures that can be utilised by the farmers to reduce the occurrence.

Both the booklet and the manual were launched during the Sharing Best Practice - Tanzania event on October 13 and copies are available on the GSSTAR website for download: www.globalseaweed.org

Early career researchers Ivy Matoju (centre) and Sadock Rusekwa (second from right) are informing the Tanzanian seaweed industry with their work.

GCRF Global Challenges Research Fund

UK Research and Innovation

Sadock's seaweed adventure

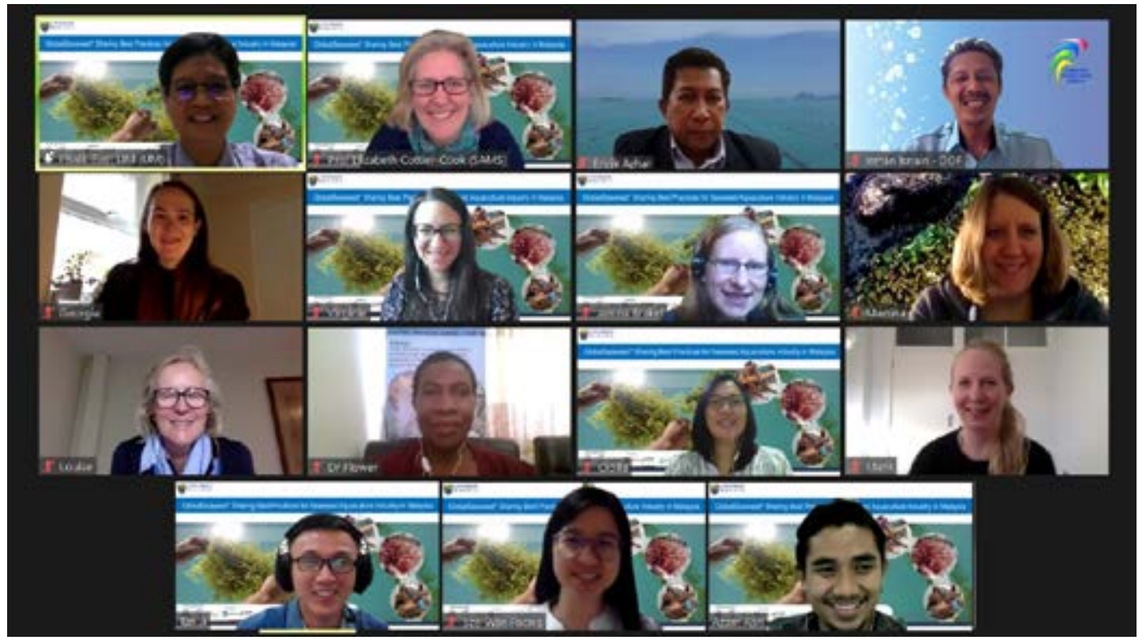
GSSTAR early career researcher Sadock Rusekwa has collected 400 different specimens of macroalgae to be included in the University of Dar es Salaam herbarium, Tanzania.

On top of that, Sadock has also prepared a database on the macroalgae specimens that have been collected since 1976.

The result is that the entire collection is now digitised and available online. The specimens are classified to species level and some to genus level. The database can be accessed through the following link: https://www.gbif.org/dataset/631cec26-8d92-4fcc-98ba-a4ab9bcb75e7.

Meanwhile, Sadock is working to prepare two manuscripts for publication.

The first is a checklist of seaweeds in Tanzania based on historical and contemporary collections in the UDSM herbarium. The other manuscript focuses on the characterisation and distribution of native eucheumatoid species in Tanzania, which will draw on results from Sadock's fieldwork along the country's coastline.



The Malaysian Sharing Best Practice event was well attended

Practical advice for farmers at Malaysia's Sharing Best Practice event

A new E-book for the Malaysian seaweed farming industry was launched at the Sharing Best Practice event hosted by the GlobalSeaweedSTAR Malaysian team, in partnership with the Department of Fisheries Sabah.

Titled 'A practical guide to the aquaculture of *Kappaphycus* and *Eucheuma* in Malaysia', the E-book is a bi-lingual publication that provides practical solutions to some of the recurring issues, such as climate change, in the country's seaweed farming industry.

The launch was followed by presentations from GlobalSeaweedSTAR researchers and Mr Azhar bin Kassim of the Department of Fisheries in Malaysia.

Our own 'top researcher'

GlobalSeaweedSTAR scientist Prof Lim Phaik Eem from the University of Malaya, was recently announced as a Top Research Scientist Malaysia.

This award, presented by the Academy of Sciences Malaysia, has been initiated since 2012 but there have only been 134 recipients, including 22 this year.

Prof Phaik Eem's work on using science to provide solutions to safeguard the seaweed aquaculture industry in developing countries is critical to the aims of GlobalSeaweedSTAR.

She said: "The involvement in the GlobalSeaweedSTAR project has allowed me to expand my research scope and work with fellow expert scientists from the UK, the Philippines, Tanzania and many other countries to make societal impact through science."

COP26 hears of the challenges faced by seaweed farmers

GlobalSeaweedSTAR scientist Dr Flower Msuya gave a stark warning about the effects of warming waters on seaweed production in Tanzania when she addressed an event at COP26.

Unable to attend the Glasgow event in person, Dr Msuya, the programme developing partner lead in Tanzania, gave her address via a recorded message to the UNFCCC Resilience Day.

She warned that record sea surface temperatures of up to 38ºC off Tanzania and the island of Zanzibar had given rise to problems with disease and pests. She said: "These temperatures are already too much for seaweed growth and especially for the high value seaweed called cottonii.

"Over the years we have been monitoring these changes and how they are affecting people.

"Because of higher temperatures we are seeing diseases like ice-ice and epiphytes causing a decline in seaweed production.

"So, what does this mean? It means our farmers are in a vulnerable position and are at a high risk of losing product and losing the activity that is their livelihood."

The solution – farming in deeper water of two to six metres at low tide – had its own challenges, Dr Msuya explained.

"In deeper water, temperatures are more stable, the conditions are more stable, so diseases are less. We are doing research into nature-based solutions and science-based solutions to get results and we are sharing these with the farmers.

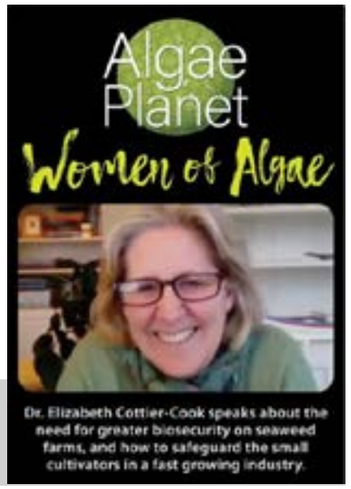
"But the challenge we are facing is that more than 80 per cent of the farmers are women, who can't swim and do not have boats to access deeper waters. How do we train women to swim and how can they get boats to access the deeper water areas. There is a big challenge to finance this."

GlobalSeaweedSTAR scientist Dr Flower Msuya

In the news...

Among the recent media highlights of our work was an interview on the BBC World Service programme People Fixing the World, when Dr Flower Msuya talked about her work on the programmme in Tanzania. Programme leader Prof Elizabeth Cottier-Cook was interviewed by Algae Planet for its 'Women of Algae' series.

Listen at https://www.bbc.co.uk/sounds/play/p09sd2wb



Watch at https://youtu.be/S9VGkrjW520

Recent publications

Asri, A., Le Masson, V., Montalescot, V., Lim, P.E., Nor, A.M., Hussin, H., Shaxson, L. (December, 2021). The role of migrants in the Malaysian seaweed value-chain. Marine Policy, 134, 104812. https://www.sciencedirect.com/science/article/pii/S0308597X21004231?via%3Dihub

Kambey, C.S.B., Campbell, I., Cottier-Cook, E.J., Nor, A.R.M., Kassim, A., Sade, A., Lim, P.E. (2021). Seaweed aquaculture: a preliminary assessment of biosecurity measures for controlling the ice-ice syndrome and pest outbreaks of a Kappaphycus farm. Journal of Applied Phycology. https://doi.org/10.1007/s10811-021-02530-z

Kambey, C.S.B., Campbell, I., Cottier-Cook, E.J., Nor, A.R.M., Kassim, A., Sade, A., Lim, P.E. (2021). Evaluating biosecurity policy implementation in the seaweed aquaculture industry of Malaysia, using the quantitative knowledge, attitude, and practices (KAP) survey technique. Marine Policy, 134, 104800. https://doi.org/10.1016/j.marpol.2021.104800

Faisan, J.P., Luhan, M.R.J., Sibonga, R.C., Mateo, J.P., Ferriols, V.M.E.N., Brakel, J., Ward, G.M., Ross, S., Bass, D., Stentiford, G.D., Brodie, J., Hurtado, A.Q. (2021). Preliminary survey of pests and diseases of eucheumatoid seaweed farms in the Philippines. Journal of Applied Phycology, 33, 2391–2405. https://doi.org/10.1007/s10811-021-02481-5

Ndawala, M.A., Msuya, F.E., Cabarubias J.P., Buriyo, A., Cottier-Cook, E.J. (2021). Seaweed biosecurity in Tanzania: lessons to be learned from other major plant crops. Environmental Challenges, 5, 100319. https://doi.org/10.1016/j.envc.2021.100319

Tan, PL., Poong, SW., Tan, J. Brakel, J., Gachon, C., Brodie, J., Sade, A., Lim, P.E. (2021). Assessment of genetic diversity within eucheumatoid cultivars in east Sabah, Malaysia. Journal of Applied Phycology. https://doi.org/10.1007/s10811-021-02608-8

Wale, C., Nagabhatla, N., Yeojin, K., Cottier-Cook, E.J. (2021). Trends and Patterns of the Seaweed Industry and Its Links with SDGs. In: Leal Filho W., Azul A.M., Brandli L., Lange Salvia A., Wall T. (eds) Life Below Water. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-71064-8_128-1

Ward, G.M., Kambey, C.S.B., Faisan, J.P., Tan, P.L., Daumich, C.C., Matoju, I., Stentiford, G.D., Bass, D., Lim, P.E., Brodie, J., Poong, S.W. (2021). Ice-Ice disease: An environmentally and microbiologically driven syndrome in tropical seaweed aquaculture. Rev Aquac., 00, 1– 26. https://doi.org/10.1111/raq.12606

A further seven papers have been supported by the GlobalSeaweedSTAR Fund, which supports seaweed-related research projects across the globe. For the full list of publications, see: https://www.globalseaweed.org/?page_id=1154

Diversity is key to resilience

Located within the rich biodiversity area of the Coral Triangle, the Philippines' largely coastal population relies heavily on a healthy ocean to sustain their economic freedom and livelihoods. As overfishing and climate change pose increasing threats to the country's fishing and tourism industries, seaweed farming presents a sustainable alternative that can potentially regenerate ecosystems.

Kappaphycus and *Eucheuma*, of the genus eucheumatoids, thrive in tropical and subtropical waters and at present represent the world's most highly farmed variety of algae. While both red seaweeds are classified as carrageenophytes (based on their composition of carrageenan, a hydrocolloid used to produce food, pharmaceutical and industrial products), *Kappaphycus* is the more valuable of the two, and its cultivation constitutes a major source of income for coastal communities.

But the farming of macroalgae comes with its own set of vulnerabilities: both *Kappaphycus* and *Eucheuma* are prone to a bacterial plague disease known as 'ice-ice' disease and epiphyte infestation, which at onset, can result in the loss of entire farms. Moreover, in recent decades these populations have been producing lower yields, lower amounts of carrageenan of lower quality, and have been found to be increasingly susceptible to disease and crop failure as a result of changes in water temperatures.

To address this issue, Michael Roleda and his team is using **GlobalSeaweedSTAR funding** to assess the molecular diversity present in wild populations of *Kappaphycus* in two locations in the Philippines. Researchers discovered wild populations of *Kappaphycus alvarezii* in Guiuan in Eastern Samar, and *Kappaphycus striatus* in Bolinao in Pangasinan. Between the two locations, nine genetically distinct genetic types of *Kappaphycus* were found, and the research later confirmed the classification of native species in Bolinao as *K. striatus*. The ensuing report is the first of its kind to document this specific type of wild *K. striatus* in this area. While only two sites were investigated — resulting in a fairly narrow set of data — the research indicates the high likelihood of discovery of unutilized wild strains of *Kappaphycus* in the Philippines. For this reason, Roleda suggests, "extensive efforts to characterize the genotypes of wild *Kappaphycus* strains are warranted".

"These newly recognized haplotypes indicate a reservoir of unutilized wild genotypes in the Philippines, which could be taken advantage of in developing new cultivars with superior traits" (Roleda, 2021).

Haplotypes in this context refer to a particular set of genes within one organism, which were inherited from a common parent organism, whereas genotype refers to the complete genetic makeup of one organism.

The complex vulnerabilities currently faced by seaweeds are, research suggests, at least in part attributable to the homogenization of *Kappaphycus* that has occurred over the last fifty years. This has occurred because these cultivars (the seeds and seedlings which are consistently reproduced from a common ancestor), originate from the Philippines but have been distributed all over Southeast Asia and as far as Africa and South America through what is known as clonal vegetative propagation, ie. the cloning of one parent seaweed over and over again.

While this method has played a central role in the creation of burgeoning seaweed industries in these sparse locations, it has also inevitably resulted in a pronounced lack of genetic diversity between these cultivated populations — in turn, stagnating productivity, and increasing their vulnerability to external variables. Researchers know that increasing the genetic diversity of crops can mitigate these vulnerabilities. Another significant positive ramification that diversification could bring is increased capacity and economic security for seaweed farmers in the region. Inequality is a widespread issue in seaweed farming economies — while businessmen and corporations higher up on the value chain are able to make considerable profits in the industry, particularly due to increasing demand for carrageenans worldwide, they participate minimally in the research, support and development that would strengthen the industry.

Farmers, on the other hand, are largely dependent on the government for bailouts when crops fail due to disease or climate factors, and rely on middlemen and brokers to set market prices for their produce. The availability of a more resilient, productive seaweed cultivar, while strengthening cultivation itself, would also further economic security and empower farmers to set fair prices for their own produce. While analysis of the growth rates and potential productivity of these new wild strains is slated for further research, the discovery and genetic analysis of these wild discoveries represent an exciting prospect for increasing productivity, resilience and sustainability in local seaweed economies.

The discoveries warrant further research, says Roleda, into determining specific types that would be suited for cloning and the establishment of new cultivars, as well as the viability of the widespread replacement of current cultivars used by farmers in the Philippines and in other tropical and subtropical regions.

For features on our other GlobalSeaweedSTAR Fund projects, visit www.globalseaweed.org