Forum Euroméditerranéen des Instituts de Sciences Economiques

THE NEXT SOCIETY
Policy Brief Series
January 2022

Project funded by the EUROPEAN UNION

A window of opportunity for the South Med region to grow a thriving biotech economy through entrepreneurship*

By Abdel Hamid Sherief

Author

Abd El Hamid Sherief is currently a Sustainable Development MSc. Graduate Fellow at the American University in Cairo with a specialization in Green Technologies. He has worked in the Oil & Gas sector both in local and regional roles and is MCIPS certified in procurement & supply. He is also a member in MedYCA Network (Mediterranean Youth for Climate Action), launched by the Center for Mediterranean Integration, as well as SGAC Egypt (Space Generation Advisory Council) and MVA Egypt (Moon Village Association). His current research focuses on the usage of marine algae for desalination brine remediation.

Executive Summary

South-Mediterranean countries are in need of increased economic diversification as a way to create jobs and increase resilience to the volatile global economy. One path towards such diversification is to enhance the entrepreneurial potential in STEM fields (science, technology, engineering and mathematics) like green and blue biotechnology and their water-energy-food applications. Globally, agricultural biotechnology (technologies used to modify living organisms: plants, animals, and microorganisms), was valuated at 50.05 billion USD in 2019 with expectations of reaching 72.2 billion USD in 2024[1]. Also, blue biotechnology (biotech applications related to marine ecology and resources) within the European Union (EU) region has witnessed investments of 336 million Euros in the period between 2014 and 2020[2]. As South Mediterranean countries enjoy a substantial coastal line; similar economic potential can be harnessed. These two subcategories of biotechnologies can potentially provide economic opportunities to South-Mediterranean countries especially if circular economy entrepreneurship was encouraged and administrative procedures were streamlined.

This policy brief aims to show how the biotech sector, in its waste valorization and bio-blue economy aspects, could thrive in the South-Med region if supported with appropriate policies that are science-informed and empowering to entrepreneurial innovation allowing for a more enabling startup ecosystem. The brief shows that while global competition may affect the ability of South Mediterranean countries to pursue ambitious biotech industrialisation in

* This policy brief was peer reviewed by Dr. Maryse Louis, FEMISE.
[1] Agricultural Biotechnology: Emerging Technologies and Global Markets https://www.bccresearch.com/market-research/biotechnology/agricultural-biotechnology-markets-report.html
[2] Doussineau, M., Gnamus, A., Gomez Prieto, J., Haarich, S. and Holstein, F., Smart Specialisation and Blue biotechnology in Europe, EUR 30521 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-27753-8, doi:10.2760/19274, JRC122818.

highly technical medical fields, agricultural biotech and blue bio-economy entrepreneurship could be easier to scale up; especially with rising global interest in regenerative / low impact water-energy-food nexus solutions and carbon fixation. The brief provides insights of concern to policy makers, based on the entrepreneurial experiences of three early-stage blue and agri-biotech startups. Academic-industrial integration, administrative reform and synergetic links with the emerging IT industry in South-Med region, are highlighted, among other parameters, as policies in need of implementation. In addition, harnessing the power of North-South and regional collaboration and the drive towards environmentally friendly businesses, could help encourage the emergence of more bio-entrepreneurs in South-Med countries.

1. Introduction

Biotechnology[3], as an economic sector, tends to thrive in countries with a strong scientific research environment and robust and substantial capital markets, that would feature venture capital firms willing to take risks on long-term investments such as biomedical trials or new drug development. In developing countries, there is a high degree of dependence on governmental resources for research and development (R&D) which are often limited due to more pressing public spending needs. As a result, developing countries still need to develop their own "niche" in biotech R&D segments given the limited technology availability and funding. More specifically, green and blue biotechnologies could be potential segments for South-Med countries.

While biotechnology seems to be popularly recognizable via medical and pharmaceutical enterprises; its applications within the water-energy-food nexus and climate change are increasingly explored. According to the OECD report on Industrial Technology & Climate Change (2011), biotech applications could save humanity a collective of 1 to 2.5 billion tons of carbon per year, by 2030[4]. According to Global Markets Insights, the market size of biotechnology was estimated to be 497 billion USD in 2020 with a forecasted growth rate of 9. 4% between 2021 and 2027[5]. Since South Mediterranean countries have ratified the Paris Accords on Climate Change, green biotech would help create economic value while committing to climate change mitigation targets. In this sense, biotechnological applications hold a lot of potentials for this region.

First, in terms **of job creation**, a research report (December 2020) shows that the EU region is supported by 223,000 direct jobs due to biotech in addition to 710,000 indirect jobs within the extended support services and supply/value chains[6]. Similar trends could be expected in South Med region if this sector is provided with needed support.

Second, the pandemic didn't only highlight the importance of establishing local biotech capabilities in developing nations, but also underlined the need for the **green transition** as a stimulus to the slumbering economy. Such drive isn't only led by governments but corporates as well, like Novo Nordisk, a major pharmaceutical company that has awarded more than 17

[3] According to the revised definition of the Organization for Economic Co-Operation and Development (OECD) "*is the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services*" and the World Economic Forum refers to it as "A broad range of technologies that employ living organisms or parts of them to make diverse products".
[4] Industrial Biotechnology and Climate Change https://www.oecd.org/sti/emerging-tech/49024032.pdf
[5] https://www.gminsights.com/industry-analysis/biotechnology-market
[6] https://www.europabio.org/wp-content/uploads/2021/02/201208_WifOR_EuropaBIO_Economic_Impact_Biotech_FINAL.pdf

million USD in June 2021, via its foundation, to 12 different research projects in the fields of green environmental and industrial biotech[7].

Table 1. Exports of South-Med Countries with EU

South-Med Country	Share of EU in trade
Tunisia	57.9 %
Egypt	24.5 %
Morocco	56 %
Algeria	46.7 %
Lebanon	30.3%
Libya	51 %
Jordan	14.7%

Source: European Commission. https://ec.europa.eu/trade/policy/countries-and-regions/

The European Union Green Deal, endorsed in December 2019, would begin to have effects on trading partners who don't follow similar carbon taxation schemes as the EU via the "Carbon Border Adjustment Mechanism" (CBAM) as per the analysis carried out by the Economic Research Forum (ERF)[8]. This shall have great implications on South-Mediterranean countries that rely on trade with the EU as shown in the table 1[9].

Thirdly, these sectors can provide an opportunity to **enhance North-South scientific biotech collaboration** through EU funded programs. For example, the Union for the Mediterranean report of blue economy projects[10] estimates that the gross value added of bio-prospecting in European waters to reach 1 billion Euro[11].

Fourthly, biotechnology can provide **solutions to waste management,** not only via treatment (like in composting waste / sludge for biogas), but also via producing materials of biological origins that are bio-degradable, or ones created via circular economy supply chains. A startup demonstrating such potential is Chitosan Egypt (which is supported by the EU-funded THE NEXT SOCIETY initiative) that produces chitosan (a versatile bioactive polymer) through recycling 500 tons of seafood waste yearly in Egypt[12].

The brief features the experiences of three aspiring early-stage start-ups in the fields of agri-biotech and blue biotech with policy making recommendation targeting the South-Mediterranean region. The insights are necessary in providing some tools on how to support and accelerate the commercialization of both agri and blue biotech research as it moves from academia to industrial implementation.

2. Biotech Entrepreneurial scene in the South-Med region

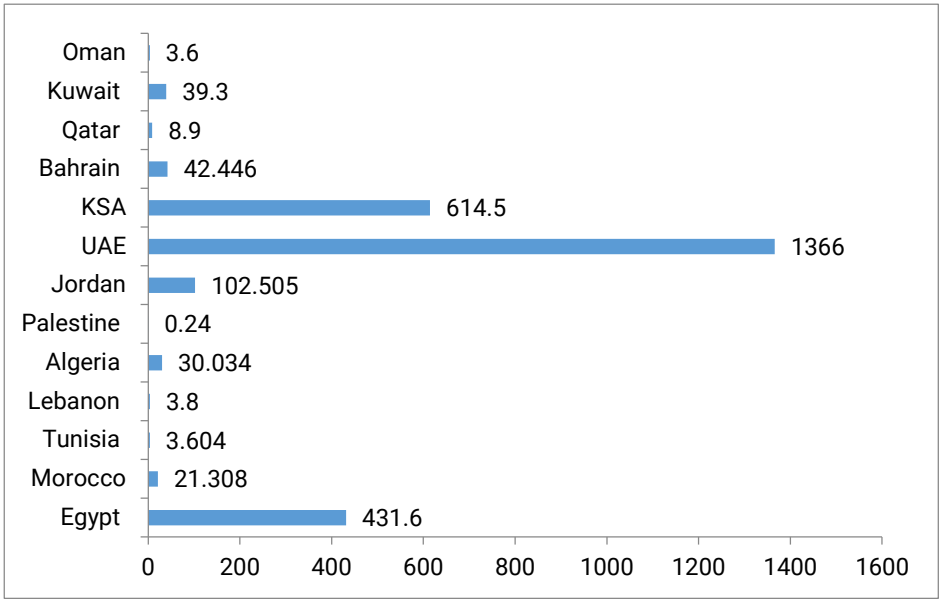
The entrepreneurship in the South-Med region is still in its early stage. The entrepreneurial youth deploy technology and maverick attitudes to find solutions to problems they face in their societies. However, they are often faced with forms of economic governance that could be cumbersome and inefficiently costly which leads to increasing economic development barriers[13]. At the same time, the biotech sector requires substantial capital to move from the research phase to the commercialization phase and hence additional costs and complicated

[7] https://novonordiskfonden.dk/en/news/twelve-biotechnology-projects-boost-the-green-transition/
[8] https://erf.org.eg/publications/potential-effects-of-the-eus-carbon-border-adjustment-mechanism-on-the-turkish-economy/
[9] https://ec.europa.eu/trade/policy/countries-and-regions/
[10] Such as bio-prospecting (searching for valuable biochemicals in nature) in the Mediterranean Sea (within aquatic organisms) like ULIXES and the Mediterranean Science Commission (CIESM);
[11] https://ufmsecretariat.org/wp-content/uploads/2017/12/UfMS_Blue-Economy_Report.pdf
[12] https://www.thenextsociety.co/chitosan-egypt#:~:text=Chitosan%20Egypt%20is%20specialized%20in,families%20in%20Fayoum%20whose%20only
[13] https://www.weforum.org/agenda/2019/04/5-key-challenges-facing-the-mena-region-ahead-of-our-global-summit/

administrative procedure could affect the business feasibility and discourage biotech researchers to move to this next phase, which encounter losses for the sector.

More particularly, investment in start-ups shows a discrepancy across MENA countries (Figure 1), which depends on the country's wealth (petrol rich countries of the Gulf Cooperation Council and others) and the population size (Egypt being the largest Arab World/South Mediterranean country).

Figure 1. South Mediterranean countries startup investments vs. GCC countries in 2021 (in Million USD)



Source: Wamda and Digital Digest Monthly review

Moreover, investments towards relevant biotechnology sectors are still low in the MENA region compared ot other technology sectors, such as foodtech, fintech and e-commerce (table 2)[14]. This clear bias towards non-biotech sectors could be due to several factors that favours investement in these sectors, such as: 1) the lower costs of prototyping and validation, 2) the presence of sizeable population of programmers / coders within the region and 3) their potential of digital expansion and 4) the easier procedures in terms of licensing. At the same time, the biotechnology sectors suffer from complex procurement channels of input materials that are imported, or limited in the local markets in the case of industrial processes and hence these biotech sectors don't have the same flexibility and low input costs as in other sectors.

Table 2. startup categories raised funds in 2021

Category	Funds raised in MENA in 2021 (in million USD)	Percentage of all MENA raised startup investments
Sectors that could benefit from biotech		
Agritech	134.9	5.00%
Health tech	36.7	1.31%
Clean tech	31.7	1.17%
Examples of other sectors receiving more funding		
Foodtech	602.8	22.36%
Fintech	502.2	18.63%
E-Commerce	378.9	14.05%
Mobility	168.4	6.24%
Logistics	154.8	5.74%

Source: Wamda & the digital digest

[14] https://www.wamda.com/2022/01/mena-startups-raised-206-million-december-2021

3. Regenerative biotech in agriculture waste management and the blue economy

While the MENA region as a whole generates an amount of waste than is almost equal to the global average, some South-Med countries generate more waste per capita than both the regional and global average (e.g. Algeria, Palestine, Lebanon)[15], as shown in figure 3. It is also to note that the lack of integrated waste management, constitutes both a lost economic opportunity and an environmental/public hazard and exacerbate the negative social/environmental consequences.

Figure 3. MENA Waste Generation rates

Source: World Bank Report 'What A Waste, 2018

When it comes to blue biotech, the South Med region can benefit from its substantial access to an extended coastal line (Morocco 2500, Algeria 1100, Tunisia 1148, Libya 1770, Egypt 2450, Gaza Strip 40, Lebanon 225 and Jordan 26 kilometers). Farming seaweed, other than just harvesting from the wild, is of great importance for conservation, as seaweed fisheries in the area are under threat of overharvesting.

In Morocco, for instance, where the seaweed sector earns the country 31 million Euro yearly (as of 2014), the government had to place restrictions on removal of seaweed from its national habitat due to the "Red Gold" rush of exporting red algae, with a yearly quota at 6040 tons as reported in 2014, which is a major reduction from the peak wild harvesting of 14,000 tons in 2009[16]. With the increase in Moroccan fishing fleets (tripled since the 90s), the government encourages shoreline aquaculture and the development of a strategy for a blue economy initiative that is based on monitoring biodiversity, finding alternatives to dwindling natural fisheries and aquaculture[17]. The Moroccan Blue Economy national initiative could constitute a good best practice for potential similar seaweed biotech projects in other South Mediterranean countries especially if integrated with the production of other seafood items like clams / abalone and mollusk. Morocco managed to attract foreign investments in the seaweed field with startups like the Dutch Seaweed Company that used a grant from the

[15] https://openknowledge.worldbank.org/bitstream/handle/10986/30317/211329ov.pdf
[16] https://english.alarabiya.net/life-style/travel-and-tourism/2014/09/10/Hard-times-for-red-gold-divers-in-Morocco-s-El-Dorado
[17] https://thearabweekly.com/aquaculture-offers-lifeline-foundering-moroccan-fishermen

Netherlands Enterprise Agency (RVO) to cooperate with a local Moroccan cooperative; employing 15 local farmers[18].

The market size for carrageenan products (extracted from seaweed) in Africa and the Middle East has been estimated at 80 million USD with expectations of reaching 100 million USD by 2021[19]. They are important for the food and pharmaceutical industries and hence, local demand in South Mediterranean countries is often met with imports.

Another motivation for this kind of enterprise is the number of generated jobs. The World Bank estimates that one job could be created for each 10 ton of dry weight of farmed seaweed, and with an additional sum of 500 million tons are produced yearly, 50 million more jobs would be created globally[20]. This amount of additionally farmed seaweed could sequester around 135 million tons of carbon and create protein extracts of 50 million tons while producing biofuel energy equivalent to 1.25 billion MWH, globally.

In addition, when it comes to blue biotech, regional cooperation can yield significant research & development achievements, such as the MED-ALGAE project that encompassed at least two South-Med countries, Egypt and Lebanon, besides Italy, Malta and Cyprus. The participating Lebanese team won the 2016 National Energy Globe Award.[21]

4. Challenges facing the Biotech sector as voiced by interviewed entrepreneurs

For the purpose of this study, three early-stage startups in green biotech sectors (waste management of organic residue for agricultural biotech applications and blue bio-economy) have been surveyed for firsthand accounts on the motivations behind establishing their projects, challenges related to bio-entrepreneurship and how they overcame these challenges.

Project Description	Link to academia	Water-Energy-Food nexus applications	Products	Impact of COVID-19
Novel Treatment of agricultural / industrial bio-waste using thermal processing (Led by Dr. Magdy Mohamed (Egypt)	The project's research & development is funded via the "Egyptian-Finnish academic project : Plant Breeding, Genetics and Biotechnology"	Biochar, (the residual high carbon material after pyrolysis of organic material) helps mend saline soils; a condition that reduces yield/cause crop failure	Several chemical input feedstock materials like Furfural / Acetic Acid, Levoglucosan and methoxyphenol + biochar & feedstock oil.	As public awareness increases regarding health hazards; waste management became looked at as an important aspect in fighting diseases, shedding light on the mission of the project.

[18] https://www.government.nl/latest/news/2021/05/24/africa-business-week-pioneering-with-seaweed-in-morocco
[19] https://www.marketdataforecast.com/market-reports/middle-east-and-africa-carrageenan-market
[20] https://documents1.worldbank.org/curated/en/947831469090666344/pdf/107147-WP-REVISED-Seaweed-Aquaculture-Web.pdf
[21] http://www.enpicbcmed.eu/communication/lebanon-med-algae-project-wins-national-energy-globe-award

KN Marine for seaweed cultivation (Algeria) (Led by Karima Bougueroua)	The project rallies the support of a special-interest club of marine biology and ecology volunteers to help with seaweed collection, cataloguing and sorting; such club has academic ties.	Seaweed farming doesn't compete with limited fertile / arable land and scarce water resources irrigating crops	Agar, carotenoids, and biomass for processing and refining.	As seaweed could be dried and stored till borders open up (for trade), or till demand bounces back, seaweed cultivation process to be an industry that is agile and resilient towards shocks like the pandemic.
Algaenoor: growing microalgae using desalination brine (Egypt) (Led by Abd El Hamid Sherief)	The project's experimental trials are conducted as part of the Sustainable Development Program at the American University in Cairo	The project utilises desalination brine to produce valuable biomass for food /feed, biofuel and brine remediation; using algae salt uptake potential	Beta Carotene, protein meal, lipids (refined into biodiesel), glycerol; brine bio-remediation and carbon fixation.	Delayed research & development due to lockdown restricting access to laboratories. Used lockdown time for refining the business model via program like GIMED / INVESTMED and Berrytech Go2Market.

4.1. Startup 1: Novel treatment of agricultural/ industrial bio-waste using thermal processing (Egypt)

Set in the field of green technology, this project tackles bio-based agricultural and industrial waste to produce agrochemicals/ soil enhancers like biochar, bio-pesticides and other high value feedstock chemical ingredients via the pyrolysis process. Aside from profitability, due to how congested the countryside could be, the storage of agricultural waste on land creates a suitable environment for pests that pose a risk to humans, livestock and the next crop cycle. According to some studies, agricultural waste left in the open releases a CO2 carbon equivalent at the rate of 1 ton against every ton of organic waste left to decompose with the IPCC report showing that 3% of human emissions coming from decomposed organic waste[22]. Also, burning residual waste like rice straw releases 7300 kilograms of CO2 equivalent per hectare per year[23]. This project is enabled by the Egyptian-Finnish research collaboration and has been motivated by Egypt's significant amounts of generated agricultural waste each year that could benefit from the innovation achieved by this pilot project.

The key reported challenges are**:**

- **Securing initial funding** has been cited as a major obstacle despite the promise of high returns. As per the principle investigator's calculations, assuming the utilization of just 55,000 tons per year of agricultural waste, the project could generate a net profit before tax of 1,532,500 EGP (85,000 Euro) just from the sale of biochar and substantial sales revenue from bio-pesticides reaching 73,490,000 EGP (around 4 million Euro). The initial costs of the pyrolysis reactor itself can be significant as seen in a

[22] https://www.agric.wa.gov.au/climate-change/composting-avoid-methane-production
[23] https://www.sciencedirect.com/science/article/abs/pii/S0048969721009633

comparable study conducted in KSA where the capital costs of the initial setup were estimated at 2 million USD (around 1.75 million Euro) without consideration for land lease, or initial purchase of agricultural waste to start the production cycle and only at the limited capacity of 10 ton per day)[24].

- **Academic R&D budget is not sufficient for scaling up**: The trials relied on the Egyptian-Finnish Research collaboration whose grant was also used to update the laboratories of the FCRI and ARC research centers. Academic grants are often limited in scope / monetary allowances / grant duration so the academic researcher investigating the commercialization of the project would have to adopt a "do it yourself" attitude to reduce the overall budget. This could have a negative effective and demoralizes this emerging class of researchers-turned entrepreneurs. Despite the lack of funds, the team managed to validate their business model as the produced biochar was tested by 218 farmers and the project received queries from 1,000 farmers who were interested in mending their land soil due to the increasing salinity levels.
- **Supply chain issues**: The research project recommended the inclusion of community stakeholders, governmental and NGOs so that a robust system for communicating findings and closing the supply and value chains from collected waste to final products, bio-based pesticides and herbicides as well as valuable chemicals. Fragmented and unreliable agricultural waste streams that don't follow a standardised system for collection impacts the possibility of building a business model since input materials (agricultural / industrial waste) are hard to quantify, or predict (in addition to fluctuations in amounts and grade).
- **Lack of public investments in R&D**: The project team emphasised the need for investment in research & development as a legitimate expenditure from the public budget. This is hard to envision at a time when many countries within the Middle East witness governmental gradual withdrawal from public sector spending. Most South-Med countries have low % of GDP allocated to scientific research (Algeria: 0.1%, Egypt: 0.6%, Jordan 0.4%, Morocco 0.7%, Palestine 0.5%, Tunisia 0.7%)[25] and Lebanon[26] 0.2% at a time the world average in 2018 is 2.2%[27]

4.2. Startup 2: The Blue bio-economy (KN Marine, project led by Karima Bougueroua , Algeria)

As Algeria's unemployment rate reached 12.83% in 2020[28]; creating jobs via the blue bio-economy is needed. KN marine estimates the potential of 100 million USD by 2030 to be earned from the developed seaweed sector with created job opportunities to 1,200 workers. The team witnessed the following hurdles:

- There are **no policy frameworks for managing an integrated "blue economy" system**. This creates territorial conflicts over suitable areas for seaweed farming in competition with fishing fleets. Establishing a cooperative-based framework would allow synergetic coexistence between seaweed cultivation and the fishing industry in a way that would boost fish stock yield and increase biodiversity.
- There is a problem with **lacking the necessary supplies** related to such industry; including the laboratory infrastructure for propagation of the seaweed. That is particularly felt within segments of the project that integrate aquaculture systems.
- **Bureaucracy and restrictive governmental rules** have affected the ability of the team to attract foreign investments. Foreign investors find it hard to penetrate the Algerian market due to protectionist laws like the 2009 regulation mandating companies to have minimum "51%" of any established joint venture in Algeria of strategic

[24] https://www.mdpi.com/1996-1073/14/19/6048/htm
[25] http://uis.unesco.org/apps/visualisations/research-and-development-spending/
[26] https://www.orientation94.org/uploaded/MakalatPdf/warakat%203mal/fhomeidan.pdf
[27] https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS
[28] https://www.statista.com/statistics/408055/unemployment-rate-in-algeria/

importance[29]; since such ruling is applied across different economic sectors, it affects the ability of biotech startups to initiate technology transfer into the country via partnerships with international companies that would prefer keeping a controlling stake in the company, or investing via an international consortium of financiers, further fragmenting the total shares.

The startup tried to address those challenges with the following actions

- Examining the proposals for aquaculture enterprise support and submitting them to the government suggesting administrative reform via holding meetings with the Ministry of Fisheries to "pitch" the value proposition of seaweed cultivation in future climate-adapted food and aquaculture systems. Many of South-Med countries may have startup support schemes, but they are often not properly communicated, or accessible or too time / resource consuming, so such dialogue is needed.
- Discussions with the Ministry of Fisheries and Fish Resources propelled the development of joint public-private communication proposals to develop reports on how the regulatory code can be streamlined, simplified and cleared to support logistics, processing and marketing locally/abroad. Inclusion of governmental entities like CNRDPA Algeria (Centre National de Recherche en Pêche et Aquaculture: National Center for Research in Fisheries and Aquaculture) is needed for advising policies based on quantitative / qualitative evidence.

THE NEXT SOCIETY initiative supported KN Marine, via the Tech Boost Bootcamp and Tek2HUB Program implemented by Algerian consultancy Brenco: the team participated in a bootcamp which included training on funding and business model development as well as intellectual property management including planning the R&D work towards patenting.

4.3. **Startup 3:** Algaenoor, Microalgae potential in bioremediation of desalination brine (Egypt)

Under the blue technology sector, Algaenoor, an early-stage startup still at the R&D phase, aims at using the salt uptake properties of algae like D. Salina for the remediation of desalination brine. By 2022, Egypt could produce 550,000 to 825,000[30] cubic meters of desalination brine per day and by 2050, the amount of brine shall reach between 6.4 and 9.6 million cubic meters per day[31]. Desalination brine is used as a resource rather than a toxic waste to produce high value molecules: beta carotene, lipids and high protein meal. In addition, algae extracts could be used as fertiliser / soil enhancer to increase crop tolerance to salinity. The startup team indicated that a 20-acre algae farm could fix 19,170 tons of CO2 and produce 29.6 tons of beta carotene with 1800 gallons of biodiesel per acre per year and 4-15 tons of protein per hectare per year more.

Challenges listed by the startup team:

- **Governmental regulations** restrict access to important supplies necessary for R&D (like some Nitrogen compounds) affecting production efficiency optimization. Also, governmental permits for marine projects, are very difficult to secure.
- The trial **funds** secured via university, namely the American University in Cairo & Heriot Watt University (United Kingdom) only allow to cover lab scale; while commercialization attempts would require full scale pilot demonstration that could be costly (5 million EGP; around 278 thousand Euros).

[29] As highligted by Doug Wallace, the US Commercial Attache to North Africa and Pierre Gattaz, from Radiall French Electronics Co: https://apnews.com/article/bfd6c17b6eb54edea55b666fb64b535b
[30] https://www.egypttoday.com/Article/1/91123/Egypt-to-complete-19-desalination-plants-within-18-months
[31] https://www.reuters.com/world/africa/water-poor-egypt-eyes-quadrupling-desalination-capacity-5-years-2021-10-21/#:~:text=Egypt%20now%20has%20installed%20desalination,to%20figures%20from%20the%20fund.

- **MENA startup scene in general is less courageous about biotech ideas** as they are deemed to have high initial capital investments and high risks of the produced chemicals not being able to compete with the quality grade of imported items.
- The presence of **customs / duties and fees** onto lab equipment makes industrial R&D very expensive. This creates a backlog of delayed lab tests as lots of researchers have to depend on a few central labs (that could afford lab equipment).
- There are **few marine biology labs dedicated for algae cultivation** and academic studies are more confined to surveying local marine flora rather than production.
- Startup accelerators require a minimum viable product (MVP) and algae-based MVP is costly to develop.

How the team tackled those challenges?

- Trying to find substitutes of restricted chemicals, like utilising agricultural fertilisers to compensate the need for lab-grade nitrates. Also, engineering school connections helped with procuring samples from a desalination plant for testing with plants to benefit from the USAID Centre of Excellence of Water Research and the International Water Management Institute to help with permits/ approvals.
- New design consideration for the MVP is being considered so that a pilot demonstration could be developed at much lower cost.

Conclusion and Policy Recommendation

While global competition may affect the ability of South Mediterranean countries to pursue ambitious biotech industrialisation in highly technical medical fields, agricultural biotech and blue bio-economy entrepreneurship could be easier to scale up; especially with rising global interest in regenerative / low impact water-energy-food nexus solutions and carbon fixation. Bridging the gap between academia and industrial implementation seems to be a recurring theme among the three surveyed early stage startups in addition to the need for governmental administrative process simplification as well as formulating policies to be evidence and science based.

Designing policies, to be based on science and public-private partnerships, should be a major key performance indicator for local governments that may utilise carbon credit trading schemes as a way to finance regenerative biotech enterprises. Reducing research cost and barriers of commercialisation via multidisciplinary integration with information tech / business programs and value chain consolidation, would be needed.

While global competition may affect the ability of South Mediterranean countries to pursue ambitious biotech industrialisation in highly technical medical fields, agricultural biotech and blue bio-economy entrepreneurship could be easier to scale up; especially with rising global interest in regenerative / low impact water-energy-food nexus solutions and carbon fixation. Bridging the gap between academia and industrial implementation seems to be a recurring theme among the three surveyed early stage startups in addition to the need for governmental administrative process simplification as well as formulating policies to be evidence and science based.

Designing policies, to be based on science and public-private partnerships, should be a major key performance indicator for local governments that may utilise carbon credit trading schemes as a way to finance regenerative biotech enterprises. Reducing research cost and

barriers of commercialisation via multidisciplinary integration with information tech / business programs and value chain consolidation, would be needed.

Policy recommendations for agricultural biotech

Biotech projects tackling climate change / water scarcity resilience, shall be strategically linked to existing governmental assets within rural communities; like agricultural cooperatives that could be hub locations for distributing biotech products/ receipt of input ingredients (agricultural waste). This closes the circular economy loop in areas like Nile Delta where 33% of the soil is degraded and bio-additives are needed to mend it.

Biotech projects producing low-carbon / carbon-neutral solutions, shall apply for carbon accreditation / attestation schemes that allows biotech-entrepreneurs to generate revenue against sequestered carbon at the time when MENA region is witnessing the emergence of voluntary carbon trading platforms (like in UAE and KSA).

Synergising the work of biotech entrepreneurs with agri-biotech companies that utilise sensors, GIS (Geographical Information Systems), and crop automated systems, could improve the commercial viability to the bio-agrochemical markets with consolidated supply chains. Same with agri-biotech mobile applications featuring platforms of subscribers / service users. An example could be seen in Tunisian agri-biotech startup "Ezzayra" that could increase the yield and profitability of the agricultural process by 30% via their integrated farm management system as indicated by Yasser Bououd; one of its founders[32].

Contracting & Procurement departments assigned to major desert reclamation projects shall have "local content" policies that encourage tendering processes that include and encompass agri-biotech startups and small-medium enterprises.

Policy recommendations for blue-biotech

There is a need for establishing national centers of research excellence on algae with a focus on commercialisation of research findings and improving the local "technology readiness" levels. In addition, dedicated startup incubator programs, attached to universities, should provide prototyping support (lab space/ materials) to biotech proposals to ease the costs of MVP development and would link up business / economic researchers / students with biotech / STEM innovators. Such "bio-parks" could be designated as "free zones" where customs and tax exemptions are enjoyed.

Regional cooperative protocols, possibly sponsored by organisations like the Arab league can disseminate experiences and lessons learnt in fishery management and integrating seaweed cultivation programs. Such programs could aspire to have accreditation programs for "blue carbon offsets" that could help finance startups and SMEs.

Time-value studies of governmental policies and administrative procedures are needed for business setup permits, both terrestrial (shoreline) and at sea. Such studies should reveal the redundancy in approval procedures and lead to a public governance "lean" six-sigma streamlining project especially in countries where approvals need to be acquired from two bodies of government; military (navy) and civil (municipality). Permitting could help synchronise seaweed cultivation to alternate with fishing /spawning months, reducing coastal "seasonal poverty" and ensuring the replenishment of natural fisheries.

[32] https://worldcrunch.com/tech-science/in-tunisia-a-digital-revolution-for-agriculture-takes-root

Central planners should advise power and desalination plants to follow a hybrid design that facilitates capturing carbon for injection into brine ponds used for algae cultivation with such emission offset opportunities to be highlighted in environmental impact assessment (EIA) studies.

Blue biotech could help the mature oil & gas sector in South-Med countries to address green transition requirements via biofuel divisions where chemical refinement is passed on to algae biofuel production (biodiesel / bio-hydrogen) not only via sponsoring innovation challenges (as corporate social responsibility), but as co-investors.

Repurposing degraded lands (no longer arable) as well as blocked/neglected irrigation canals in South-Med rural regions, could allow for low-cost inland algae cultivation. In addition, inland aquaculture farms that suffer from a supply glut (with reduced prices), aquaculture farms could be easily converted to grow algae especially in months where the fish cycle is disrupted by extreme heat waves, or extreme cold (there are marine algae species that withstand both; allowing infrastructure usage year round).

There is a need to allocate a subsidy program to local producers of algae-based protein replacements of imported soy, corn, barley, or other feed grains besides establishing local commodity markets for innovative local feed for mass adoption.

There is a global interest in water-energy-food nexus innovation as well as opportunities to develop carbon mitigation / fixation targets with much more targeted and focused investment appetite than local financiers. Hence, supporting initiatives like THE NEXT SOCIETY can help with connecting local innovators with international venture capital firms interested in establishing presence in emerging economies and developing countries (such as the likes of Y Combinator).

EU Horizon Program for research collaboration already benefits researchers within Sub-Mediterranean countries especially in areas like the water-energy-food nexus and at the same time, EU funds startup incubation programs, like THE NEXT SOCIETY Program and others like GIMED / INVESTMED, so synergies between the two could be cultivated, where R&D work carried out within the Horizon program could immediately be placed onto a “commercialization track” within incubation and acceleration programs for a faster academia-industrial linkage.

Entrepreneurs who participated in this study

Karima Bougueroua – KN Marine, Algeria

Passionate about nutrition, Karima Bougueroua is a PhD student in physiology of nutrition and health and CEO of KNMarine. She is very interested in the seaweeds. KNMARINE is an innovative economic project that aims to exploit the marine resources of Algeria. The industry is based on technology that is the most modern language because it can improve the country's competitiveness through its triple efficiency.

Magdy Maher – Novel Agro-technological Approaches for Transforming Agriculture and Industrial Bio-wastes into Bio-products, Egypt

Dr. Magdy Maher Mosad Mohamed is the principal investigator of the "**Novel Agro-technological Approaches for Transforming Agriculture and Industrial Bio-wastes into Bio-products"** project. Dr. Magdy M. M. Mohamed got the "World's Best Teacher and World's Best Boss" at the "Biochar Systems for Africa International Workshop" held in Kenya in 2016. His project aims to improve the management of biowaste in Egypt and thereby reduce its potential negative impacts on human and animal health, the environment and the economy.

Abd El Hamid Sherief – Algeanoor, Egypt

Abd El Hamid Sherief is the founder of Algeanoor. He is currently a Sustainable Development MSc. Graduate Fellow at the American University in Cairo with a specialization in Green Technologies. Abd El Hami has a bachelor in Accounting (Business Finance) also from the American University in Cairo and minor courses in architecture in addition to a diploma in environmental engineering.

Project
funded by the
EUROPEAN UNION

This Policy Brief has been produced with the financial support of the European Union. The contents of this brief are the sole responsibility of « the authors » and can under no circumstances be regarded as reflecting the position of the European Union.

This Policy Brief is produced as part of the series of Policy Briefs on « Entrepreneurship in the South Mediterranean Region » that is undertaken in partnership between FEMISE and ANIMA Investment Network through THE NEXT SOCIETY Project.

Forum Euroméditerranéen
des Instituts de Sciences Economiques

FEMISE, Forum Euroméditerranéen des Instituts de Sciences Économiques (the Euro-Mediterranean Forum of Institutes of Economic Sciences), is a Euromed network gathering more than 100 members of economic research institutes from the North and South of the Mediterranean.

CMCI
2, rue Henri Barbusse
13241 Marseille Cedex 01
Téléphone : (33) 04 91 31 51 95
Fax : (33) 04 91 31 50 38
www.femise.org
Twitter: @femisenetwork

THE NEXT SOCIETY is an open community of changemakers, entrepreneurs, investors, corporates, NGOs, public and private innovation, research and economic development hubs from Europe and 7 Mediterranean countries: Algeria, Egypt, Jordan, Lebanon, Morocco, Palestine and Tunisia.

11 bis Rue Saint-Ferréol 4ème étage
13001 Marseille Cedex 01
Téléphone : (33) 04 96 11 67 60
www.thenextsociety.co