عمادة البحث العلمي
Deanship of Research

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Moving Forward with Confidence

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عمادة البحث العلمي | DEANSHIP OF RESEARCH

Toward An Informed, Transparent, And Accountable Response to Food Security

Every country devotes its resources to maintaining its security—the cornerstone upon which all its components can grow and prosper—and one of the most important kinds of security that countries seek to achieve is food security, which represents both a priority and a major challenge as well as a basic need for all human beings. Moreover, it constitutes a daunting challenge for governments, as they get to a critical point and become affected by all global events, whether political, economic, or even climatic. This makes any attempt to achieve food security a relentless pursuit, and here comes the role of research and researchers in finding solutions, examining problems, and exploiting all resources to mitigate the negative effects on food security.

The role of research in addressing food security issues is not complementary or secondary, but rather decisive, vital, and responsible, and by delivering research findings, researchers by default shoulder the responsibility of protecting the peoples' food so as to ensure cumulative wealth and socio-economic welfare. However, each country has specific problems defined by its geographical location, natural resources, and climate, which need to be addressed by scholars through sustained efforts to turn them into real opportunities for achieving food security. Moreover, researchers assume a significant role in assessing the magnitude of future challenges and problems, thus alerting countries to prepare to confront them so as to minimize potential losses, while taking advantage of the emerging opportunities.

Although it is difficult for some countries to attain self-sufficiency, it is still possible to approach it, regardless of what conditions or resources exist. In fact, it has become easy to reach a stable state of self-sufficiency—thanks to research—particularly when there is serious and real interest in providing support and funding and creating a suitable environment that increases research output, which gives every country an opportunity to mitigate or resolve the problem.

It is worth noting that Sultan Qaboos University (SQU) supports research and provides an optimal environment to enhance research output and efficiency. Its faculty, researchers and research centers also play a responsible role in furnishing the country with research findings and studies on food security, which is a major issue the Sultanate of Oman seeks to control. This would benefit the country through achieving sustainable development goals, maintaining food security, and protecting natural resources.

This is what we discuss in this issue of Tawasul, a complete edition on food security that includes an interview with Prof. Dr. Abdullah Al-Saadi, Dean of the Agricultural and Marine Sciences College at SQU.

RMAC

Research Management & Administration Conference

In February, SQU Organizes 1st Research Management Conference

The Deanship of Research at Sultan Qaboos University (SQU), in collaboration with the Ministry of Higher Education, Research and Innovation and Qatar University (QU), will hold the first Research Management and Administration Conference on 26th - 27th February 2023.

The conference will focus on steering research towards finding solutions to societal problems, benefiting from research results, expanding research funding programs, and spreading a research culture across the industry. It also aims to exchange the best practices adopted in research management regionally and internationally, identify the challenges and issues facing research management and means of addressing them and explore international practices in measuring the quality and impact of research.

Sponsored by the Nama Group, ARA Petroleum, Shell Oman, Daleel Petroleum and Oman PDO, the event will examine the quality and efficiency of research management practices in terms of central and decentralized administration, management of research programs and relevant challenges, and the responsibility of research projects, including ethical and legal aspects of research. Another theme is the competitive aspect of obtaining research support. It will cover funding sources for external research and mechanisms of application, supporting researchers when competing for external research, strengthening research collaborations and partnerships, building research capacity, professional development in research, and defining the required research competencies. Other topics include the role of research in developing a research vision and strategy for institutions, effective scientific publishing, and how to link researchers with industry for the benefit of society.

In this regard, Dr. Ghazi Al-Rawas, Dean of Research, has stated that the conference will be an occasion to foster effective cooperation with other academic and research institutions, both inside and outside the Sultanate of Oman. He added that joint partnerships would help enhance research activities, exchange the best practices in research management, share challenges and issues affecting this matter and find appropriate solutions, in addition to monitoring the impact of research on communities.

The Dean went on: "The conference is of paramount importance to SQU, as it provides an opportunity for researchers and specialists to recognize the issues facing research. That is why the university will provide a stimulating environment to find the best practices in research management and discuss ideas among research-

ers, experts, and keynote speakers."

In his remarks, Al-Rawas revealed that the university had long maintained close research collaborations with other academic institutions to exchange expertise and achieve mutual benefits. He said: "We have always sought to promote such collaborations through holding various conferences, events, and activities related to scientific research, in addition to diversifying the topics to include all university affiliates. The university always takes the initiative to develop its relations with other local, regional, and international research agencies." Meanwhile, Dr. Mariam Al-Maadeed, QU's Vice President for Research and Graduate Studies, indicated that: "QU and SQU are committed to promoting sustainable socioeconomic development in the region in particular and in the Arab world in general. Both institutions are recognized regionally and internationally for the high quality of their knowledge and research output. They are also keen to make collaborative efforts to enhance their global standing and reputation."

Professor Al-Maadeed: It facilitates scientific and cultural exchange in strategic areas

She added, "Joint conferences and events are important pillars for this cooperation, and the Research Management and Administration Conference is a good opportunity for the two universities to continue their steady progress in the fields of higher education and research and adopt the best international standards for excellence. They have also managed to address the needs of the local community and industry, which immediately contributes to the socioeconomic development in the region."

The Qatari official stressed that such cooperation would sustain the strategic partnership, achieve the universities' missions and goals and build their research capacities. She pointed out that a joint committee was formed between the two universities to support research and innovative projects, facilitate scientific and cultural exchange in strategic areas, and thus enhance national and regional socioeconomic changes. She hoped that these collaborations would greatly encourage research, innovation, and creativity, promote opportunities for cooperation in the region and beyond, and contribute to ensuring intellectual growth between global communities.

Dr. Al-Rawas: It contributes to fostering collaboration between SQU and research institutions

Prof. Abdullah Al-Saadi:

The Sultanate of Oman made good progress on food security index

Food security is of paramount importance to the Sultanate of Oman. It has a direct impact on vital areas and is an essential component of the national economy as well as a major factor in sustainable development. Therefore, the Sultanate spared no effort in this regard, harnessing material and human resources for achieving it, being one of the priorities of the Oman Vision 2040. In this interview, Prof. Abdullah bin Muhammad Al-Saadi, Dean of Agricultural and Marine Sciences College, talks about the importance of enhancing the food security system in the country as part of implementing the Oman Vision 2040. He also addresses the challenges to increasing food security and the role of Sultan Qaboos University (SQU) in raising awareness about it by closely examining basic sectors such as agriculture and fisheries.

How important is food security to the Sultanate of Oman?

Food security is extremely important to the Sultanate and Oman Vision 2040 because it affects all segments of the society. That is why the Sultanate aims to improve its rank on the Global Food Security Index (GFSI) by heavily investing in related projects. For example, the Food Security Laboratory delivered over a hundred projects with a total investment of one billion Omani Rial. The Ministry of Agriculture, Fisheries, and Water Resources seeks to achieve higher rates of self-sufficiency for some products by directing investment into projects of major importance. This trend is in line with one of the goals of the Oman Vision 2040, i.e., to better food security. This year, the Sultanate improved its rank on the GFSI, moving from rank 40 in 2021 to 35.

What are the GFSI parameters for measuring food security?

There are four criteria: Affordability, Availability, Quality and Safety, and Sustainability and Adaptation. The first criterion measures the ability of consumers to purchase food, their vulnerability to price shocks, and the presence of programs and policies to support consumers when shocks occur. Availability measures agricultural production and on-farm capabilities, the risk of supply disruption, and national capacity to disseminate food. Quality and Safety measures the variety and nutritional quality of average diets as well as the safety of food. Sustainability and Adaptation assesses a country's exposure to the impacts of climate change, susceptibility to natural resource risks, and how the country adapts to such risks. Therefore, any challenge in any of these aspects will have a negative impact on the food security system in the Sultanate of Oman.

What are the major challenges facing the vital sectors of food security in the country?

There are several challenges facing agriculture and fisheries. To begin with, there is water scarcity, which significantly disrupts agricultural expansion in addition to salinization of water and agricultural lands. Several plant pests and diseases have adversely affected the production of such crops as lemons, palms, bananas, and different vegetables. Also, the livestock sector undergoes various problems such as the spread of diseases, lack of vitamins, and limited production of meat and milk. Other issues include overfishing, especially outside the season, the red tide, and pollution in addition to the challenges to the food production and safety sector.

Given these challenges, how can SQU contribute to food security?

The university is a think-tank covering various areas in sciences and humanities in the Sultanate of Oman. It plays an essential role in spreading food security awareness in the community. Apart from delivering teaching and research in various fields, SQU transfers knowledge to the community by offering training courses and holding scientific conferences and workshops attended by local and foreign experts. In addition, simplified forms of scientific articles are published in local newspapers and various media.

In five years, we published over 1000 refereed papers

So, how can research contribute to addressing food security challenges, especially those related to food safety?

Research is largely designed to identify and overcome some of the challenges facing food safety and security. Our researchers investigate some problems, including the contamination of agricultural products and processed foods by chemicals or biological pathogens—such as bacteria, fungi, and toxins produced by some fungi—the impact of storage methods and duration on food quality, bacterial resistance to antibiotics, and food safety practices of restaurants. Different departments produce a variety of studies that address topics related to the water sector, plant output improvement, management of plant pests and diseases, enhancement of the fish sector, and how to overcome the obstacles facing the livestock sector.

This is the role of the university in general. What about the Agricultural and Marine Sciences College, which is more concerned with food security?

The College has centered its research on the most serious challenges to the agricultural and fisheries sectors. On water resources, it conducted several studies on groundwater and how to increase it as well as on finding fresh water alternatives. Other studies examined ways to enhance

water use efficiency through applying modern and smart methods of irrigation, optimal use of the Falaj water, and soil and groundwater pollution with heavy metals and microbes. As for plant pests and diseases, three main themes were focused: 1) Developing techniques to detect pathogens that enter the Sultanate of Oman through imported plants, seeds, and fertilizers, which pass through land, air and sea outlets; 2) Most of the plant diseases that damage plant production were diagnosed, including over 40 new diseases reported globally for the first time; 3) Focusing on the integrated management

Our agricultural experiments station serves researchers and the community

of plant diseases and pests through developing biological and chemical control methods and applying genetic engineering to produce pest-resistant plants.

Researchers examine water scarcity and salinization—two challenges to agriculture

As for the livestock sector, many studies have investigated the impact of the nutritional system and the effects of using local plants on the meat and milk output, and how to diagnose animal diseases and antibiotic residues. In the fish field, various studies tackled fish biology, biodiversity in the Omani waters, detection of new species, and causes and treatment of pollution. Others focused on evaluating fisheries stocks, the sustainability of fish resources, fish farming, and marine tourism and its impact on the economy. When it comes to research, we are among the most active colleges in the region. Over a thousand refereed research papers were published in the last five years, most of which addressed the challenges to the agricultural and fisheries sectors in the Sultanate of Oman and suggested ways to overcome them. Some were carried out in partnership with other agencies inside and outside the Sultanate, and one of the major supporters of the college in its research efforts was the Ministry of Agriculture, Fisheries, and Water Resources.

The College has an agricultural experiments station; how does it serve research projects and the local community?

The agricultural experiments station supports teaching and research in the college and provides community services while preserving and sustaining natural resources. The students of the college can apply their knowledge on the ground by learning modern farming methods, irrigation systems, propagation of plants and animals, veterinary techniques, fish farming, and other experiments as part of their academic courses. The station also provides support for research projects carried out by researchers and students of the college, also offering workshops to the local community. Other activities involve tours for school students and other groups as

part of the community awareness service, and marketing its products, including dairy and animal products, dates, chicken, eggs, beehives, and indoor and outdoor plants.

What about students? Are they engaged in food security research?

Of course, students are actively involved in the projects on food security. Before their graduation, many undergraduate students choose a graduation project that deals with a challenge in the fields of agriculture or fish. They learn the basics of planning and implementing research projects, analyzing results, learning scientific writing, and presenting results, which gives them some basic skills needed in the labor market. As for graduate studies, most students investigate the problems of the agricultural and fisheries sectors, diagnosing them and trying to come up with solutions. Majority of these students are employees in the public and private sectors, and many are keen on focusing on the challenges they face in their workplace. At this point, I would like to point out that many of the peer-reviewed research papers published by the college's researchers included effective contributions by our students at the bachelor's, master's, and doctoral levels. We are talking about hundreds of studies; so, the research experience they have acquired at the university helps them in their future careers.

What about employing modern technologies to develop the agricultural and fisheries sectors?

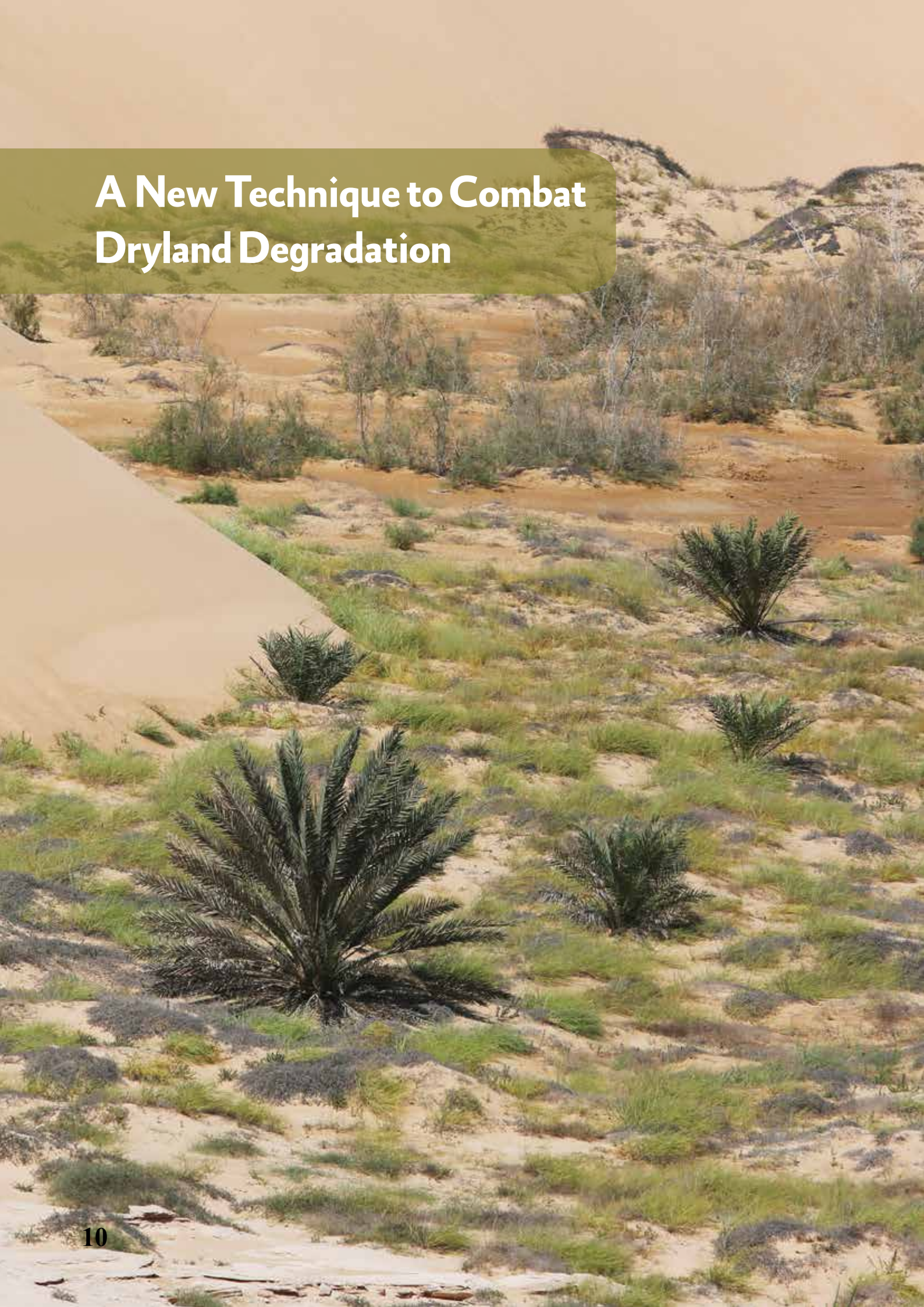
Due to the rapid development in the techniques and technology used in fishing systems, fish and food industries, farms, and irrigation, the college has sought to train students on the latest technologies, some of which brought to the university, or through scientific visits that students make to food factories, veterinary clinics, and modern farms, or through internships in some institutions or companies inside and outside the Sultanate to learn about advanced techniques and technologies used in other countries.

Finally, what recommendations would you like to make for researchers to develop the food security system?

I would suggest that researchers mainly focus on carrying out research to identify the strategic challenges facing the food security system in the Sultanate, and find appropriate solutions. I would also recommend partnerships with the public and private sectors to benefit from the existing expertise in addressing the challenges. There is also a need for optimal preparation of human resources through training students and providing them with the skills they need in their future careers in order to participate in the efforts aimed at strengthening the food security system.

Our researchers identified over 40 new diseases reported globally for the first time

A New Technique to Combat Dryland Degradation



Importance

The study is focused on discussing the biophysical aspects of soil carbon sequestration and their impact on global climate change and food security in dryland areas. It seeks to improve the management of pasture on grazing lands, fire management, management of cultivated lands, and restorative land use to reestablish degraded soils and ecosystems.

Objectives

- Examine the biophysical aspects of soil carbon sequestration and their impact on global climate change and food security in dryland areas.

Results

- Combating land degradation in drylands by afforestation using suitable tree species such as Acacia, Mesquite, and Neem.
- Restorative land use to reestablish the degraded soils and ecosystems.
- Suitable practices for soil management are the application of biosolids (manure, sludge).

Recommendations

- Afforestation using suitable tree species such as Acacia.
- Management of pasture on grazing lands.
- Management of cultivated and restorative land use to reestablish the degraded soils and ecosystems.
- Grazing management practices such as controlled grazing at an optimal carrying capacity.
- Using vegetative mulches and wise irrigation structures.

Dr. Muhammad Farooq, Agricultural and Marine Sciences College

Organic carbon is one of the organic components in soil that includes animal and plant materials that pass through various stages of decomposition. Organic carbon mainly enters the soil through the decomposition of dead animals and plants and through root secretions and microorganisms present in the soil. In most dry climates, carbon is retained by converting carbon dioxide in the air into inorganic forms, such as secondary carbonates present in the soil.

Food Security Included in the Objectives of the Oman Vision 2040

Scholars Stress the Role of Research in Achieving this

At a time when the world is facing political, economic, and social challenges, food security has become the focus of concern for all nations, both developed and developing. They make tremendous efforts to overcome such barriers to ensure food security, self-sufficiency, prosperity and welfare. In this sense, global economies seek to utilize domestic or imported natural resources to address the challenges to agricultural and marine resources, food processing, impact of climatic and economic changes, community partnership in achieving food security, and other concomitant problems that require appropriate solutions. In this report, we will shed light on food security in light of these factors and the favorable opportunities for achieving food security, the role of research in preserving food and mitigating the problems encountered and to what extent research and administrative efforts are in line with the goals of sustainable development that consider food security as one of the most important pillars of the national strategy. Given the global economic changes, free trade, steady growth of global population, climate change, natural disasters, and political tensions, food security issues are now top priorities for all countries.

Impact of Economy on Food Security

In the Sultanate of Oman, food security is linked to global economic changes, which makes it imperative for the Sultanate to keep in place sustainable food stocks and try to exploit opportunities that would lead to food stability. So, how can research find solutions to cope with the economic changes now and in the future?

Prof. Salim Zakari of the Department of Natural Resources Economics at the Agricultural and Marine Sciences College (AMSC) has shed light on the impact of rapid global economic changes on food security in the Sultanate, saying:

The recent geopolitical developments in the world have affected all aspects of life, including food security, which is closely related with the political situation. However, the Sultanate of Oman plays an effective role in strengthening its foreign relations, both with neighboring countries and beyond, which would reduce food-related crises and soften their impact. This has led to stability in general and food security in particular now and in the years to come.

Zakari underlined the importance of identifying the Sultanate's natural components for the safety of food security:

The climate is not varied, and the weather tends to be hot most of the year. There are arable lands, but there is also a water shortage, and we all know the importance of water in agriculture and food production. The country depends on rain-fed crops in limited areas only, while water reserves are generally used for irrigation.

As per the role of research in strengthening food security, he indicated that the main objectives of the national strategy for food security include prioritizing research and development, identifying advanced technologies, and localizing emerging technologies in agricultural and food production sectors. This aims to support national efforts in food security, utilize cumulative knowledge and experiences from the perspective of decision-makers to come up with common visions on research priorities, and find informed solutions using modern and appropriate technologies. Ultimately, sustainable food systems will be in place to increase local production, contribute to job creation and generate economic revenues, and thus enhance a sustainable and diversified economy for the welfare of future generations.

Zakari added that: "Research should focus on the efficient water use management to produce high value-added food products needed in Oman, such as vegetables and fruits, instead of producing 25–30% fodder that consumes large amounts of water. For example, the cultivation of fodder consumes 26000 cubic meters of water; however, with this large amount of water, we can produce four hectares of tomatoes for only one hectare of fodder, which can be imported from abroad at a low cost.

The academic also mentioned that Sultan Qaboos University (SQU) has undertaken significant research projects to solve agricultural issues and achieve food security. Researchers seek to reach tangible results that could help farmers combat diseases threatening orchards and fruits, which is one of the issues that require adequate control and treatment. This is done by identifying the causes and providing treatment in a healthy manner to ensure ecological balance and safety.

Zakari suggested that researchers working on projects may be given more time to look into the problems, find solutions, and apply their findings to benefit the society and economy.

Climate Change and Its Impact on Food Security

Climate change is a major factor that has a direct impact on food security, a reality that informs the policies of the Sultanate to import basic food products from abroad. What is the impact of climate change on food security, and how can climatic conditions be harnessed to attain food security?

Dr. Ali Al-Balushi of the Department of Geography, College of Arts and Social Sciences (CASS), argued that:

It is quite evident that climate change affects food security in Oman, as it finds it difficult to be a food-producing country. For example, Oman is unable to produce the basic commodities of wheat and rice. However, climate change has nothing to do with the current obstacles that prevent food security, rather, there are other reasons such as water scarcity, limited arable lands, and inappropriate weather conditions due to high temperatures. Being a food importing country, Oman can indirectly be affected by climate change when it hits food producing countries, which leads to soaring prices of imported goods.

To overcome this situation, Dr. Ali said:

It is necessary to secure global food reserves for the future, ensure some sources of import, and develop technologies to address such variables. We may introduce new and highly productive animal and plant strains that can withstand the weather conditions in our country, or we use nuclear or isotopic technologies to improve livestock and plant production. We also need to increase research into artificial seeding, water desalination, dry farming, hydroponics, and saline agriculture as well as using modern technology to enhance production through vertical farming, i.e., reducing areas and increasing crop production.

Regarding the role of research in addressing the effects of climate change on food security in Oman, Al Balushi said:

At the Department of Geography, we are working on modelling or predicting climate changes. For example, if there is a rise in temperatures and sea level, the question will then be: How big is the land that will be affected by these changes? As to the climate changes that take place on the bodies of water, plus high temperatures in the country, I can say that the future may be bright because the presence of water bodies alongside high temperatures can lead to high levels of evaporation and humidity in the air. This happens across mountain ranges, which may lead to increased amounts of rain on the Hajar Mountains, and thus improve water balance in the Sultanate of Oman, especially in the areas near the mountain ranges. Large amounts of rain will be made by evaporation, which could increase the flow of valleys, feed water dams and water storage, and improve soil fertility. Researchers should focus on renewable (solar) energy production by increasing research studies on the exploitation of wind energy, and dispensing with fossil fuels, the primary cause of climate change.

On the benefit of climatic diversity for food security in Oman, Al Balushi stated: "Climate change has not been that bad, especially in the coastal regions between the Sea of Oman and the Hajar Mountains. However, we should develop strategies for adaptation and response in all scenarios."

Food Security Enhances Community Cohesion

Community cohesion is one of the factors that achieve food security, as it brings together various food-producing environments by creating a cycle of cooperation, and each environment needs the other to reach a good amount of output. However, there are social challenges to attaining food security.

Dr. Hamoud Al-Nawfali of the Department of Sociology and Social Work, CASS, spoke about the role of food security in promoting stability and social cohesion. He said:

Food is the most important component of life after water, and the cycle of providing it is more difficult than that for water. In fact, it depends on water mainly, and countries that suffer from drought find it difficult to ensure food security, and foods such as meat, dairy, fish, grains, and various food products require different environments. They are produced in the seas, mountains or countryside. Therefore, this diversity makes integration of different environments significant. Different categories of the society will need each other: the one who works in fishing needs the farmer, and vice versa; the livestock breeder needs the farmer as well as the hunter, and so on, and this mutual need leads to reciprocal commercial relations, which increases community cohesion.

He added:

Food security provides social stability, and individuals will enjoy a sense of safety, even with the crises in global supply chains created by disasters or wars. Many people have left their countries driven by lack of food. That is why food security leads to stability and strengthens social cohesion, whereby everyone needs the other to provide a different kind of food.

As for the role of research in implementing what is stipulated in the Oman Vision 2040 on welfare and social protection through food security, Al-Nawfali explained:

There is no doubt that research plays an important role in achieving food security, and as we know, the Sultanate of Oman has diverse milieus, each suitable for a specific type of crop. So, researchers are required to test the production of those crops according to each environment; what could be grown in Jebel Akhdar is different from that grown in Dhofar Governorate, Al Batinah, or inland rural villages. They have to find alternatives to allow for growing some crops in different weather conditions and develop appropriate scientific methods in pesticides, irrigation, fish farming, etc. There should be studies on agriculture, fisheries, food habits and the local culture in agriculture. For example, some elderly people still insist on traditional cultivation or irrigation by immersion, and that does not contribute to achieving food security, which needs

to be addressed by raising awareness and drafting legislations to minimize the impact of this on food security plans.

Role of the Food Industry in Attaining Food Security

Agricultural industrialization is a clear indication of the progress in the agricultural sector and represents a basic pillar of food security, which should be sustainable. In addition, there should be a high degree of self-sufficiency, a decrease in imports, and increase in exports. However, this requires a lot of work at the political, economic, and scientific levels, and the question is: how can research contribute to addressing such issues by applying modern technologies?

Self-sufficiency represents the cornerstone of the Oman Vision 2040, and an urgent concern for all countries. In this regard, Dr. Ahmed Al-Alawi of the Department of Food and Nutrition at AMSC praised the government's efforts to achieve self-sufficiency, which is quite evident in vegetables, poultry, and eggs. He added that:

There are ongoing steps for improvement in this field, but the big obstacle to achieving higher rates of self-sufficiency is that we don't have domestic resources such as fodder; our problem is that we import fodder from abroad because it consumes large amounts of water and vast agricultural areas. For example, fodder includes corn and barley, and we don't produce them.

As for the challenges of self-sufficiency in food processing, Al-Alawi said:

Even if we manage to achieve optimal self-sufficiency in meat and eggs, we don't control production inputs; so, we remain vulnerable to political, economic, and climatic fluctuations. When it comes to red meat, the problem is even bigger, as local breeds are not highly productive. For example, camels give birth once a year only, and this is also the case with sheep, which don't give birth to twins—which is rare in the Omani breeds. This affects the breeders, as goats or sheep give birth once every 5–6 months and need 2 months for suckling and rest, which means they may give three births in 2 years. This problem can be addressed through a scientific

breeding program run in larger farms, but such farms are not available in Oman.

The academic stressed the importance of research in addressing the difficulties of locally manufacturing food. He said:

Research is the basis for reaching solutions to these challenges, and in order to support research projects, a solid structure should be in place to facilitate their implementation on the ground. There are great potentials at SQU—being a think-tank—to achieve progress in this regard. We must also take advantage of modern technologies to find solutions to the problems that may compromise food security. For example, in summer, Al Batinah usually suffers from high levels of humidity, which makes it difficult to use greenhouses. Now, researchers have a great responsibility to help overcome this problem to achieve self-sufficiency in vegetables, which depends partly on greenhouses. They could also help in combating the pest that affects tomatoes, palm weevil, and Witches' Broom disease of lime, the latter turning lemon trees into fruitless and ultimately being burned. So, researchers need to develop scientific solutions, and that requires plenty of time and effort.

One more serious obstacle to ensuring food security is water scarcity in Oman, said Al-Alawi, adding that it could be addressed by increasing rainfall through artificial rain seeding. He encouraged experts to seek solutions at offshore regions, and called for allocating a fund for food security research.

The Fisheries Sector: Diverse Resources Contribute to Food Security

The Sultanate of Oman enjoys all the elements that make it an attractive environment for investment in the fish farming sector. There is the marine environment, which is suitable for cultivable aquatic organisms besides investment facilities and a legal and institutional framework for the fish farming sector. However, there are enormous challenges in the preserva-

tion and sustainability of fish stocks, and the questions to be asked are: Is there a real interest in utilizing marine resources to make a significant leap in food security? What are the research findings in this respect? To what extent are the research efforts in line with the sustainable development plan?

Addressing the above questions, Dr. Saud Al-Jufaili of the Department of Marine and Fisheries Sciences at AMSC said:

Marine resources are valuable renewable resources, which help attain food security. The Sultanate of Oman enjoys enormous and diverse marine resources, having a sea coast that extends to 3165 km along the Gulf and Indian Ocean. These resources are of paramount importance, both economically and in terms of national food security. So, investing in this area can lead to food self-sufficiency. In order to sustain the national food security with reference to fish, it is necessary to optimally exploit this wealth and promote fisheries. That is why the Sultanate of Oman pays great attention to studying a lot of local fisheries, including those for abalone, lobster, ouma, and kingfish.

Reflecting on how to ensure sustainability of food and fisheries, Al-Jufaili remarked that: Globally, there is instability in the cost of importing food stuff, besides the rising shipping costs and taxes, which will lead to less imports or covering the cost of imports by raising the prices of local products. These two aspects cannot be controlled by governments or people, since they pertain to the global economy. So, we should pay attention to our marine wealth by intensifying research aimed at increasing fish or food production and processing, diversifying value-added fish products, and providing sound and wise management to ensure sustainability.

The academic added that collaborations could be fostered between SQU and other competent agencies to deliver scientific consultancies, policies, recommendations, and research results to ensure the achievement of the desired goals of the Oman Vision 2040. He said:

Our research projects have focused on presenting indicators of the economic and administrative dimensions of the fish sector sustainability. They also discussed the environmental aspects such as marine and environmental pollution, biodiversity, the state of reserves and lagoons in the Sultanate, the marine fishing law, and development of Omani ports and marine fishing fleet (traditional and commercial), which enhances the infrastructure of the fisheries sector in the Sultanate of Oman.

Treated Wastewater for Crop Production

Objectives

- Evaluate the effect of using treated wastewater in the greenhouse cooling system.
- Build greenhouses that produce crops irrigated with treated wastewater.
- Assess the potential and difficulty of using treated wastewater in the greenhouse cooling system.
- Determine microbial concentrations in the cooling pads and greenhouses.
- Measure the potential risks to human health and crop quality.
- Test the economic feasibility of using treated wastewater in the greenhouse cooling system.

Research Methodology

- Three small greenhouses (3x6m) were built at the university's agricultural experiment station.
- Two of them were connected to treated wastewater for irrigation and cooling systems, and the third to groundwater as a comparison control element.

Results

- Treated wastewater was more profitable for crop production than groundwater.
- Nutritional values, crop quality, and heavy metals were within international standards.
- Rapid algae growth was noticed in the wastewater greenhouse cooling pads compared to the groundwater cooling system, which could be minimized by covering the cooling pads with a shade net, adding some anti-algae growth in cooling tanks, using plastic cooling pads, or cleaning cooling pads from time to time.
- More types of bacteria were found in the treated wastewater cooling system, but they were not harmful to humans or plants.

Recommendations

- Using treated wastewater in the greenhouse cooling system with the application of antifouling compounds or using plastic cooling pads.
- Conducting more studies to determine the effects of using treated wastewater with long-term applications for crop production and industrial needs.

Dr. Ahmed Al-Busaidi, Agricultural and Marine Sciences College

The reuse of treated wastewater for irrigation purposes is one of the strategic options for improving agricultural production and preserving limited groundwater resources. It is one of the important non-conventional water resources and an additional and renewable source of irrigation water that partly covers agricultural needs from water, especially the growing and production of fodder crops.

Recommendations for Achieving Food Security

Dr. Msafiri Daudi Mbaga, College of Agricultural and Marine Sciences

Food security exists when every person has physical and economic access at all times to healthy and nutritious food in sufficient quantity. There are three fundamental pillars to achieving food security. These are: food availability, access to food, and food utilization.

Importance

Access to food is critical at the national and household levels to reach a state of nutritional well-being where all physiological needs are met. At the national level, Oman produces only a fraction of the food it consumes while importing most of it. Land and water scarcity are among the leading constraints to agricultural production, such that by 2050 Oman is expected to depend solely on imports to meet its food security needs.

Objectives

- Focus on the two food security pillars, i.e., food availability and access to food.
- Find alternative approaches to achieving food security in Oman.

Results

- Given water scarcity, increasing agricultural production through expansion is not feasible.

- The alternative available for Oman is food imports to meet domestic food needs, especially grains and red meat.

Recommendations

The following mechanisms were proposed to achieve food security:

- Establishing a national food trading company.

- Setting up an efficient Strategic Grain Reserve System along the lines suggested by the World Bank.

- Promoting private-sector participation in importing grain and critical food commodities.

- Increasing investment in new technologies and innovations to increase water availability.

- Creating a conducive environment for foreign investors to attract more foreign direct investments to help create jobs and improve people's incomes.

- Increasing land and water productivity through investment in relevant research.

- Developing a national strategy stipulating priority crops that should be grown in the country to conserve water.

How to Enhance Local Food Quality and Value?

Mohammed Al-Rizeiqi
Innovation & Technology Transfer Centre

Food quality and safety is a continuous process involving both consumers and food producers, as well as informing global food agencies and local food regulations. Nutritional quality is also an essential element that indicates the degree of satisfaction of consumers with food, given the shift in their lifestyle, needs, and nutritional and health values. Nowadays, consumer choices range from gluten-free, organic, traditional, or local foods to genetically modified foods. The country of origin and environmental protection are also important. Food safety is prioritized in all food laws of countries, private businesses, or international organizations such as the Codex Alimentarius Commission and World Trade Organization concerning sanitary and phytosanitary measures and technical trade barriers. Food laws vary according to the nature of the product, so they are more stringent for foods with the highest potential in terms of water activity, basic ingredients and preservatives used, as well as manufacturing and packaging processes used in food production. If we look at the value of the food chain for a food product, we will find that some food systems are concerned with the agricultural environment and the associated chemical and biological pollutants. Contaminants such as heavy metals, pesticide residues, industrial materials, and food additives are examined. That is why chemical and microbial pollutants, as well as solid materials, are among the basic problems that must be avoided in various manufacturing processes. The Sultanate of Oman has come a long way in promoting food systems as one of the strategies of Oman Vision 2040 and in line with social welfare and promoting health for all. This year, Oman is ranked 35th in the Global Food Security Index (GFSI), competing with several developed countries. The same applies to the food security and safety index, which is 73.2%. In implementing their food security strategy, countries develop food items and packaging in a way that would meet the needs of the consumer in a geographical area and conform to their national policies by providing necessary nutrients such as minerals, vitamins, and antioxidants. The product development policy is based on several components, the most important of which is the study of consumer behavior and applications of food quality and safety systems. In addition, food systems and waste management due to food loss are taken into account. Based on the strategy, competitive imported foods are examined, and social dimensions are analyzed. Then, products with higher nutritional values are developed from local raw materials. The use of appropriate technologies in manufacturing is one of the crucial factors in promoting food production and the profitability of food products on the market. Most of the new products (roughly 69%) in the market face challenges in the first year as a result of a lack of awareness of consumer needs and the absence of a comprehensive product review strategy. That is why many large industries promote research and development of food products to increase market competitiveness and open new markets for new consumers, for example, by producing food from plant sources as an alternative to animal protein in dairy products by the Eclipse Company and meat by the Light Life Company, as well as reducing the hydrogenated oil and trans fats in food items. Research and development play an important role in creating competitive and safe products, thus effectively contributing to the quality and safety of Omani products. This can be achieved by utilizing the local raw materials of fish, vegetables, fruits, and milk, and meat products to enhance the local added value and supply the local and global market with high-quality products that satisfy consumer needs and promote the national economy.

1Developing New Food Products for Changing Marketplace (2ed Edition) by Aaron L. Brody and John B. Lord

Investigating the Contribution of the Private Sector in Advancing Economic Development

The Omani Private Sector - Its Contribution and Role in Economic Development by Dr. Ashraf Musharraf, Oman Chamber of Commerce and Industry Chair in Economic Studies, is one of the latest publications of the Department of Academic Publication and Outreach, Deanship of Research, SQU.

Theme

The author defines the status of the private sector in the Sultanate of Oman and its potential to play a leading role in the development process, a role similar to that in the developed countries where there is an appropriate environment that encourages local investment and mechanisms that support such a role. Dr. Musharraf introduces the private sector in terms of classification, structure, and its relationship to the public sector. He offers an assessment of its contribution to the gross domestic product, capital formation, general budget, and the capital market. He also evaluates trade and investment, labor market development, job creation, education, research, innovation, and entrepreneurship.

Objectives

The book aims to assess the private sector in terms of contribution, role, and potential in advancing and leading socio-economic development in the Sultanate of Oman. It also examines its ability to attract foreign direct investment to positively contribute to enhancing various economic sectors and achieve sustainable development.

Importance

This is a significant publication, as it highlights the great efforts of the Sultanate of Oman to change the economic structure of its rentier economy through economic diversification, assigning a greater role to the private sector in the development process, easing the burdens and responsibilities of the government system, and promoting new investments, ideas, and technologies in the Omani market.

Did Al Batinah Fishery Foster Sustainable Development?

Huda Al-Siyabi, a researcher at the Agricultural and Marine Sciences College, has undertaken a study entitled "Assessment of Al Batinah Fishery with Respect to Sustainable Development Using a Multi-Criteria Decision Analysis Approach."The aim was to assess the progress of the Al Batinah fishery towards sustainable development using the ecologically sustainable development framework and a multi-criteria decision analysis approach. The results showed positive progress toward achieving sustainability in the Al Batinah fishery. In the period 2009-2016, scores increased from 50 to 81 points on a 100-point scale, while progress towards sustainability in human well-being climbed from 55 to 95. However, progress towards sustainability in environmental well-being was minimal, as the score moved from 42 points in 2008 to just 67 in the period 2015-2017. Further, the year 2016 recorded the best achievement in terms of progress toward sustainability, while the adopted administrative policies and practices showed a preference for socio-economic development over environmental preservation.The study indicated that the sensitivity analysis in 2016 was more favorable to improving human and environmental well-being. However, in the long run, favoring human well-being over the environment may threaten the entire fishery landscape, requiring all measures to be adapted to enhance and protect the environment.

Flaxseed Reduces Symptoms in Kidney Patients

A study conducted at the College of Medicine and Health Sciences has suggested that flaxseed is a potential therapeutic agent for attenuating all physiological, biochemical, and histological changes in experimental diabetic rats with chronic kidney disease (CKD). Flaxseed contains several bioactive compounds that have been shown to possess anti-inflammatory and antioxidative properties. Carried out by Dr. Mohammed Al-Zaabi and Dr. Badreldin Al-Hashem, the research aimed to investigate the possible effect of flaxseed on CKD resulting from experimental diabetes in rats. The impact of different doses of flaxseed on experimental diabetic rats was examined, and concomitant damage and changes in the body were observed by measuring physiological, biochemical, and histological markers.It is worth noting that flaxseed is extremely beneficial for health. It helps to reduce both high blood pressure that causes heart disease and blood sugar levels in diabetic patients, as well as in treating menopausal symptoms. It is also used in baked goods, added to various foods, and as a substitute for diet fats and eggs. The study recommended the use and development of flaxseed or its effective extracts in the treatment of CKD after undertaking more pharmacological and toxicological studies in animals and small clinical trials.

Preservation and Storage of Pomegranates

Dr. Pankaj Pathare, Agricultural and Marine Sciences College

The high incidence of post-harvest losses is the main challenge to global food security. The bruising phenomenon is one of the critical issues related to many agricultural processes. Also, it can be considered a common reason for mechanical damages to agricultural products that occur in some agricultural operations, including harvesting, handling, transporting, and processing.

Objectives

The study has aimed to investigate the time-dependent bruising incidence and physiological alterations of local pomegranate fruit as affected by impact damage and storage.

Methodology

This study used a pendulum test by applying two impact levels from different angles. Pomegranate fruits used as controls were left undamaged. The bruised and the non-bruised (control) pomegranate fruits were stored at 5 and 22°C for 28 days. Bruise measurements like bruise area and bruise volume were determined. Besides weight loss, firmness, respiration rate, and ethylene production rate were evaluated. Two prediction models were constructed for the bruised area and bruise volume changes of pomegranate fruits.

Results

- All bruise measurements increased with increasing impact level and storage condition.
- Significant differences were revealed between the investigated factors (impact, storage temperature, and storage duration) on weight loss, firmness, respiration rate, and ethylene production rate.
- Fewer changes have been observed in the physiological attributes of pomegranate fruit with a reduced impact level (including the control) and storage temperature.
- The absence of bruising on pomegranate fruits and storing them at a low temperature (5°C) reduces the risk of damage within 28 days of storage.
- These findings can help scientists, handlers, and transporters to enhance post-harvest handling and storage management in the supply chain of pomegranate fruit.
- This can be considered an important strategy to decrease the high occurrence of losses of agricultural commodities after harvest.

Recommendations

- Fostering fruit bruising sensitivity studies are beneficial for raising awareness to prevent damage during handling operations within the post-harvest supply chain.
- Employees should be given training in the following:

1) Handling the crop gently
2) Harvesting at proper maturity
3) Drying the harvest whenever possible
4) How to stuff boxes
5) Avoid over or under-filling containers

- Increased use of current automated field technologies.
- Allowing real-time monitoring and evaluation of packing lines to identify critical control points during the post-harvest supply chain.

How can SMEs Strengthen Food Security in Oman?

Amani Al-Jalboubi, Centre of Human Resources

The term "food safety" refers to handling, preparing, storing, and preventing illness and injury associated with food. Many developing countries' Agri-food sectors are dominated by small- and medium-sized firms (SMEs), which account for over 90% of all companies. Omani owners and employees of small and medium-sized businesses have been adapting diligently and innovating to meet the needs of consumers while still providing them with nutritious, safe foods.

Growing crops, harvesting, packing, transporting, cooling, storing or marketing fresh produce, and turning fresh produce into processed foods are all examples of small Omani businesses in the horticultural value chain. By providing fresh food, SMEs in Oman contribute to the food security system. Nevertheless, these businesses are under-resourced, so in order to compete in the market, they use the safe food strategy. In this way, they contribute to promoting the food security system.

At Sultan Qaboos University, faculty members of the Food Science and Nutrition Department, Agricultural and Marine Sciences College, conduct research in different fields, such as food safety and quality, food processing and engineering, and the potential role of functional foods in chronic disease prevention and management. Human nutrition researchers focus on contributing to and promoting quality of life, human health, and well-being. Several activities are designed to improve public health and the quality of life in the community.

References

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Scientific Incubators: A Practical Model for Supporting Startups

Building on the technological progress—thanks to the creative and innovative capabilities and the coordinated initiatives by research circles and public- and private-sector resources—Sultan Qaboos University (SQU), through its Innovation and Technology Transfer Center (ITTC), has launched a scientific incubator program to help innovators convert their new ideas from the laboratory or experimental form to the level of production or investment. The program is also designed to consolidate relations with the industrial organizations that seek SQU's scientific expertise, and thus achieve a knowledge-based economy by transforming creative ideas into wealth.

Scientific incubators are programs aimed at marketing science and technology through agreements between production and services sectors to deliver research applications. They focus on supporting community efforts to allow technological development as well as robust research by sponsoring collaborations between researchers and those having creative ideas on one hand and the production and services sectors on the other.

Regarding the objectives of the scientific incubator program at SQU, Zakaria Al-Wehaibi from the Department of Incubators and Innovation Development at ITTC said: We support research projects and scientific innovations in the early stages of innovation, and consider their economic feasibility and marketing opportunities in order to transfer them to society as marketable products and services. Furthermore, we seek to develop technologies generated in scientific laboratories and contribute to creating jobs, products, and services of added value to the economy and society.

He added: The program also aims to promote incubated projects to attract inves-

tors, convert projects into startups, raise awareness about the importance of incubating technology, translate research results into products, and enhance research and development practices. Moreover, the program can supply the national economy with technology- and knowledge-based small companies and provide integrated services for incubators through the facilities of the program in the scientific, commercial, and legal fields such as intellectual property protection, linking up with financing funds and investors, business consultancies, and connecting with specialists in the field of technology.

Reflecting on the mechanism of the program, Al-Wehaibi said:

In the first stage, student projects or innovations classified in the third level of the innovation readiness level index are incubated, i.e., proving the principle of work in a laboratory (proof of concept). In the second stage, the needs of the participants are addressed by facilitating the procedures for using scientific laboratories and research resources, allowing access to research databases that help understand and develop the innovation, seeking the assistance of specialized mentors, each in their field, providing advisory sessions on legal and commercial matters and training workshops on entrepreneurship and intellectual property, and contributing to the manufacturing and development of the prototype. In the final stage, the participants graduate with start-ups or licenses that benefit other institutions.

Al-Wehaibi underlined the importance of activating business accelerators at the university through partnerships with the industrial sector due to their role in setting visions that achieve comprehensive and sustainable development and in overcoming obstacles in the path of emerging and small projects.

Zakaria Al-Wehaibi
Innovation & Technology Transfer Centre

"Tuhlub": A Student Startup in Food Security

Tawasul sheds light on one of the projects participating in the scientific incubator program. It is designed to optimally utilize various local algae and seaweeds and produce organic products in the food, industrial, and environmental fields.

The startup "Tuhlub" produces natural feed for marine and ornamental fish from local ingredients, mainly algae. This diverse group of aquatic organisms contains a high level of protein ranging from 36–48% and a balanced mixture of nutrients that help the fish grow properly. It is considered an alternative to the industrial feed and imported products, and one of the main products in the Omani market of marine fish targeting marine fish breeders, farms, and fish farming companies.

The company seeks to develop its product in several stages. First, it will focus on market positioning and build a consumer base so that the annual production reaches 96 tons of marine feed and 48 tons of fresh fish feed. This is to attract consumers, contract with fish farming companies, and encourage algae farming companies to provide the raw material. Then, the company will increase its production to 1440 tons of marine feed and approximately 72 tons of fresh fish feed, establish a strategic headquarters, expand human resources, and add new products in the cosmetics and food industries.

Three Papers on Food Security At Local And International Conferences

Sultan Qaboos University (SQU) is keen on furnishing the Omani scientific community with its research findings and academic publications in various fields, and food security is one of the most important areas on which researchers focus due to its significance to societies.

The SQU faculty has taken part in several conferences that addressed food security. Three presentations can be mentioned here: "Producing Virus-resistant Tomatoes to Achieve Sustainability in Agriculture and Food Security" by Dr. Muhammad Shafiq Shahid; "Plant Diseases and Their Threat to Food Security in the Arabian Peninsula" by Dr. Abdullah Al-Saadi; and "Rural Land Use Change, Agricultural Transformation, and Food Security in Al-Batinah" by Dr. Al-Nazir Ramadan.

Dr. Shahid's paper is of paramount importance because it focuses on evaluating virus-resistant tomato varieties using genes resistant to tomato leaf curl disease as well as using different agricultural biological methods to improve, evaluate, and test the yield of the crop. It is hoped that this research will produce a number of sustainable solutions to tomato leaf curl disease and thus produce tomato varieties that have effective resistance against this disease.

Dr. Al-Saadi, Dean of the Agricultural and Marine Sciences College, presented a summary of the main fungal, viral, and prokaryotic factors causing diseases in plants in the Arabian Peninsula, with a special focus on the diseases of crops of economic value in the Sultanate of Oman, and on sustainable management of plant diseases using chemical methods, biological control, and genetic engineering.

The third paper, by Dr. Ramadan of the Department of Geography, College of Arts and Social Sciences, revealed the change in rural land uses, agricultural transformation, and food security in Al-Batinah by remote sensing as well as the relationship between science and policies related to food systems versus climate change and potential factors. His paper recommended that sustainable intensification of agriculture be promoted to increase the food supply to feed the growing population.

Majority of Nurses Value the Work Environment

Dr. Sulaiman Al-Sabei of the College of Nursing has investigated the impact of the work environment on nursing outcomes and patient care in the Sultanate of Oman. In his study, the work environment of nursing staff and the relationship between this environment, patients' health and safety, and the quality of care provided were examined. Data was collected from 2,403 nurses and 1,800 patients in twelve public and six private hospitals in various regions and governorates.

The research revealed that 2034 nurses, i.e., 97.9%, highly valued their work environment, and there was a positive correlation between appreciating the work environment and the quality of care provided to patients. The more appropriate the work environment, the more it contributes to the provision of higher-quality care. The results also showed an inverse relationship between the work environment and patient safety risk. When the environment is adequate, and there are enough nurses in each department, support from the administration, and a clear mechanism for the professional development of employees, a decrease is noticed in medical and medication errors, the number of patients falling, and the spread of viral and bacterial infections. The study suggested that more nurses should be employed in public and private health institutions, a clear mechanism for professional development, and a system with accurate indicators to assess the quality of care provided to patients and their safety during their stay in the hospital. It stressed the importance of aligning indicators of quality assurance with regard to patient health and safety with global standards.

Raising Nutritional Awareness among Students and Staff

Researcher Dalila Al-Bahri of the Agricultural and Marine Sciences College has made a study entitled "General Nutritional Knowledge Among SQU Omani Students and Employees." It was designed to assess general nutritional knowledge and determine the validity and reliability of the research tool, i.e., a questionnaire to assess the participants' knowledge of dietary recommendations, nutrient sources, healthy food choices, and food-related diseases.The participants included 655 students and 273 employees. They were asked to fill out a questionnaire of 61 questions with a total of 117 points. The fourth-year students majoring in nutrition were taken as a standard.The research findings revealed that 90% of the participants did not know the recommended number of servings of vegetables per day, 50% ignored the recommended number of servings of fruits per day, and a large percentage of the participants could hardly identify food items that contain a high or low percentage of protein, sugar, and salt. They also had difficulty identifying the food items that were high or low in fiber, as well as healthy alternatives to red meat. Although they were aware of the association between high salt and fat intake and diseases, they were unaware of the diseases related to low fiber intake. The nutrition students obtained the highest score compared to all groups in all areas of knowledge as well as in the total result. The results also showed that there were significant gaps in knowledge about nutrition relative to the basic recommendations and that there was a variation in the levels of nutritional knowledge according to different demographic characteristics. Based on the current data, the study confirmed the critical need to promote nutritional awareness among SQU students and staff.

Medication Adherence among Patients with Chronic Diseases

Objectives

- Examine medication adherence by characteristics of patients with chronic diseases.

Research Methodology

This cross-sectional study included 800 patients from eleven governorates with chronic diseases such as high blood pressure, ischemic heart disease, heart failure, diabetes, asthma, and chronic obstructive pulmonary disease (COPD).

Results

- Eighty and a half percent of the patients showed moderate to high medication adherence.
- Adherence varied widely according to gender, employment, frequency of medications per day, and COPD diagnosis. When using multivariate analysis, retired patients, COPD patients, and those whose chronic illness exceeded ten years showed low adherence to medication.

Recommendations

- It is necessary to understand medication adherence among patients with chronic diseases and any relevant factors to develop strategies to improve medication adherence, reduce health complications and financial costs of healthcare and positively influence future policies to ensure population health.
- The demographic and clinical characteristics of the patients should be taken into account to enhance medication adherence.

Dr. Huda Al-Noumani, College of Nursing

Chronic diseases pose a significant threat to health and socioeconomic development. Worldwide, these diseases are responsible for about seventy-one percent of mortality. Medication adherence is less than fifty percent, especially in developing countries. The factors that affect medication adherence have to do with the patient's beliefs, knowledge, and socioeconomic status. Other factors concern the type of treatment and prescribed medications in terms of quantity, duration, and frequency of taking them.

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