Biotechnology, Food Security and Regulatory Concerns in OIC Member States: Prospects and Challenges

Upscaling plant breeding from traditional to genomic selection in Kazakhstan

Transforming plant growth and disease management using microbiome technologies in rice

Novel somatic hybrids and autotetraploid breeding parents for Citrus scion improvement

المنظمة الإسلامية للأمن الغذائي
Islamic Organization for Food Security
l'Organisation Islamique pour la Sécurité Alimentaire

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FOOD SECURITY HUB

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CONTENT

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Dear Readers,
assalamu'alaikum warahmatullahi wabarakatuh!

It is my great pleasure to present you with the 12th edition of IOFS Food Security Hub. This edition focuses on biotechnology for food security in the OIC Member States.

Agricultural production is under constant pressure due to changing climate patterns like erratic and uneven rainfall patterns in combination with floods, temperature upsets, and eruption of new pests and diseases. Agricultural biotechnology (Ag biotech) has been universally accepted as a leading science to achieve food security in the climate change era. The wars, conflicts, poor legislation, and political instability in several OIC Member States are causing hunger and malnutrition. Ag Biotech can be a promising solution when complemented with conventional breeding to bring wonders for the improvement of crops and livestock to upraise the living standards in OIC Member States.

The modern biotechnology such as genetic engineering, genome editing, RNA-mediated gene silencing, next-generation sequencing, genome mapping, and next generation breeding tools assisted with data science has accelerated the precise genetic modifications for climate resilience and food security. The Muslim world including Middle East, Africa and Asia, is among the most vulnerable to climate change coupled with increasing population and depleting resources. Water scarcity and rising temperature are the top problems that directly affect people life by damaging food system which breeds uncertainty and violence, already happening within the OIC Geography. Thus, these issues call for replacing or augmenting the traditional approaches with modern biotechnology. For instance, the biotech based biofortification of wheat, rice, cassava, beans, and vegetables can provide fast track solutions for hidden hunger in the Muslim world.

Although, some biotechnological tools like GMOs have brought controversies but these have been replaced with modern approaches like VIGS, and CRISPR/Cas allowing to bypass the regulatory concerns in some countries. Similarly, somatic hybridization, transgenic approaches, genomic selections, and microbiome technologies can tackle challenges related to regulatory compliance, biodiversity conservation, crop diversification, and food crisis. In this issue of Food Security Hub, you will see that high crop yields and sustainable ecosystem can be achieved through modern biotech tools and techniques. Even, the gap that existed for the rapid acceptance of GM crops has also been filled by the extensive research and alternate approaches. For the safe future of OIC Member States biotech techniques and crops are inevitable to fill our food basket with enough and diverse food to bring peace, and prosperity in society. Moreover, the humanitarian assistance for food security focused on long-term stability to build food secure communities is also important in OIC Member States.

Sincerely,

Prof. Yerlan A. Baidaulet

IOFS Director General

BIOTECHNOLOGY, FOOD SECURITY AND REGULATORY CONCERNS IN OIC MEMBER STATES: PROSPECTS AND CHALLENGES

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Introduction

The Organization of Islamic Cooperation (OIC), 2nd largest international organization founded in 1969, plays a crucial collaborative role among its 57 Member States, spread over four continents including Africa, Asia, Europe, and South America. The combined population of OIC Member States is approximately 1.8 billion, making up more than a quarter of the world's population. These nations, while culturally, economically, and politically diverse, share a common challenge of food security. Most populations live in rural areas and depend on agriculture for their livelihoods. Thus, sustainable food production to feed a growing population under changing climate is a common goal. Traditional farming practices, coupled with environmental issues such as land degradation, water scarcity, heat waves, emerging of new pests and diseases, and increasing climate volatility have created an urgent need for innovative solutions. Biotechnology including Genetically Modified Organisms (GMOs) and Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) technology has emerged as a promising answer (Figure 3).

Globally, USA, Brazil, Argentina, Canada and India are top five among 26 countries growing Biotech crops on 91 percent of the total area under cultivation of these crops (191.7 m ha, Figure 1). From the OIC geography, Sudan, Indonesia, Pakistan, Malaysia and Bangladesh are cultivating Biotech crops, mainly cotton, golden rice, sugarcane and others. Interestingly, none of the top five countries growing Biotech crops, except Brazil, have a Biotech Information Center. While OIC geography has seven out of 18 fully operational national/regional nodes of Biotech Information Centers located world-wide in three continents. These centers respond to specific information needs, promote and advance a broader public understanding of crop biotechnology, and monitor the local agri-biotech environment (Figure 2). There is a need to create an enabling environment across OIC geography to address all concerns related to biotech crops and benefit from them to address the challenge of food security.

Although GMOs have been utilized in agriculture since 1994 with the introduction of GMO tomatoes, their acceptance has always been a matter of environmental health, and ethical concerns. Traditional GMO technology involves the insertion of foreign DNA into crops to confer desirable traits, such as pest resistance or drought tolerance. This has allowed for substantial increase in crop yields but has also spurred debates regarding potential long-term impacts on human health and the environment. Bt genes *(derived from Bacillus thuringiensis)*, for example, have been integrated into several key crops like cotton, corn, and potato. Despite its usefulness, like other GMOs, they also face similar regulatory and public acceptance challenges.

Alternatively, CRISPR technology opened new avenues in agricultural biotechnology to precisely edit an organism's existing genes without introducing foreign DNA. This novel approach can thus avoid some of the controversy surrounding GMOs. However, regulatory bodies worldwide are still struggling with how to appropriately classify and regulate these CRISPR-modified organisms. Despite the challenges and controversies, the potential benefits of biotechnology to ensure food security cannot be underestimated.

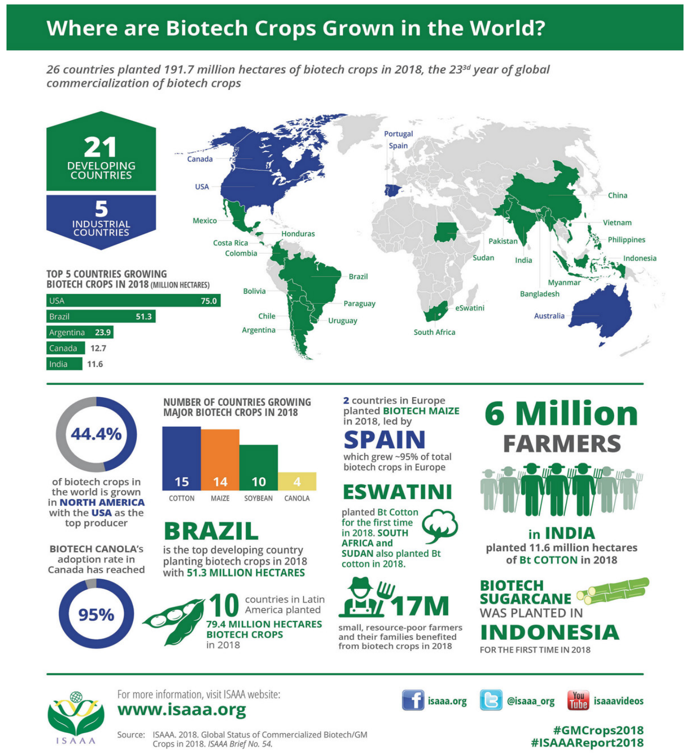

Figure 1: Biotech crops grown in the world.

Figure 2. Global Biotech Information Centers: fully operational national/regional nodes located in three continents. These centers respond to specific information needs, promote and advance a broader public understanding of crop biotechnology and monitor the local agri-biotech environment.

To fully realize these benefits, however, the development of a comprehensive and science-based regulatory framework is crucial. There is a need to balance the potential benefits of biotechnology against potential risks, taking into account the specific contexts and needs of OIC member states.

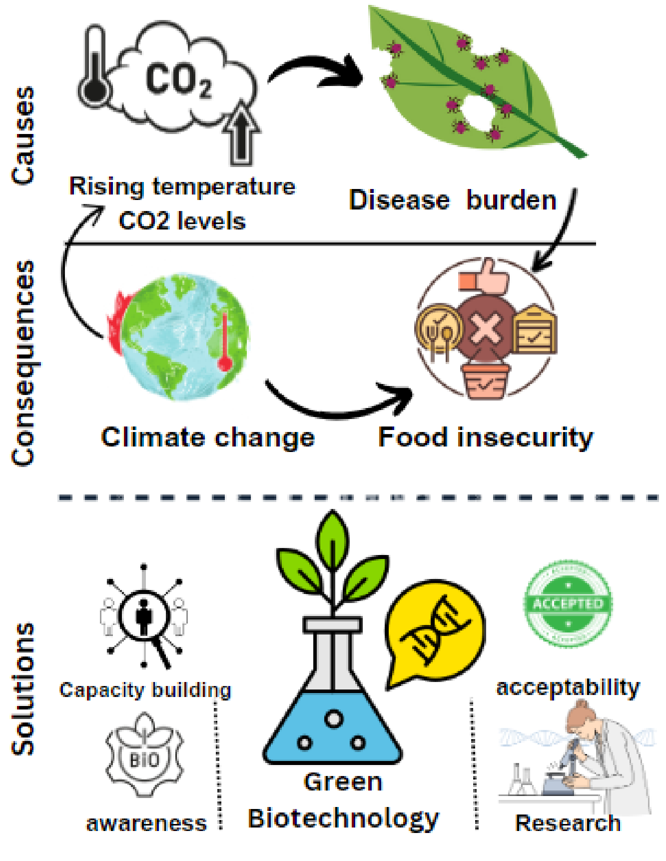

Figure 3: Summary of the scenario of climate change and food insecurity. A. Cause and effect relationship of climate change phenomena (caused by rising temperature and high emissions of CO2) and food insecurity. B. Biotechnology can be a robust solution provided with long-term collaborative research, capacity building in OIC countries, public awareness and acceptability.

Furthermore, the capacity to apply biotechnology effectively and responsibly depends on the development of adequate infrastructure, human resources, and institutional capacity.

This paper will explore the state of biotechnology, particularly GMOs and CRISPR technology in OIC member states, including i) the challenges and opportunities for enhancing food security, ii) regulatory concerns, and iii) potential way forward for managing potential risks. This study will provide valuable insights for policymakers, researchers, and stakeholders in OIC member states and beyond.

Food Security and Green Revolution in OICs

Food security is a situation "when all people, at all times, have physical, social, economic and financial access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". This encompasses four key elements: availability, access, utilization, and stability covering SDG2 "zero hunger". The OIC spans a diverse range of geographical contexts, from the arid regions of the Middle East and North Africa to the fertile plains of South Asia and sub-Saharan Africa. These diverse environments, combined with varying levels of economic development and political stability, result in a wide range of food security challenges among OIC countries. Around 200 million food insecure individuals (25% of global undernourished population) live in OIC member states. While some OIC countries, such as Malaysia and Türkiye, have achieved substantial progress towards food security, others, particularly in conflict-affected regions, face severe food insecurity and malnutrition. Therefore, ensuring food security through transforming agricultural systems is essential to scale up adaptive capacity of food production systems from "gene to fork".

The Green Revolution was aimed to significantly increase agricultural production worldwide, particularly in developing countries, through the introduction of high-yielding varieties of cereals, synthetic fertilizers and pesticides, and the expansion of irrigation infrastructure. This period witnessed a significant increase in agricultural productivity, contributing to substantial reductions in hunger and poverty, including OIC countries like Pakistan, Afghanistan, Indonesia, Iran, Malaysia, Morocco, Tunisia, and Türkiye. However, the Green Revolution also had its limitations and unintended consequences. The high-yielding varieties bred under optimum conditions required high levels

of inputs, such as chemical fertilizers and pesticides, and were often less resilient to environmental stresses, such as drought and pests, compared to local varieties. This increased vulnerability of agricultural systems and environmental hazards, along with loss of biodiversity. Moreover, the benefits of the Green Revolution were unevenly distributed, often favoring wealthier farmers who could afford the required inputs and had access to irrigation, while marginalizing smallholder farmers and those in less favorable environments. This contributed to increased inequality and social tensions in some regions, particularly in sub-Saharan Africa, the impact was less pronounced, due to limited infrastructure, lack of inputs, and unfavorable climatic and edaphic factors. On the other hand, the quality of grains of green revolution varieties was compromised and efforts are being made under different programs to replenish grain quality by biofortification interventions.

Genetically Modified Organisms and their regulatory concerns

The lessons from the Green Revolution coupled with the potential of biotechnology can provide a foundation for building sustainable, resilient, and inclusive food systems. The GMOs and CRISPR technology may offer the potential to enhance crop yields, nutritional quality, and resilience to biotic and abiotic stresses. However, collaborative efforts among OICs and international partners is a prerequisite to achieve this goal.

Traditionally, the typical GMOs whose genetic material has been altered using genetic engineering techniques, typically through the introduction of a gene from a different species like Bt gene(s) and glyphosate resistance gene(s) introduced in food and fiber crops have been successful in providing crops with built-in (endo-toxin) pest and herbicide resistance, but their use also raises regulatory concerns. In 2019, the global acceptance rate of GM crops varied from 100% in Argentina to its moderate acceptance in Asian countries like Pakistan, restricted access in Europe, and its absolute ban in "Türkiye". A broad spectrum of potential benefits and risks associated with the use of biotechnological tools for food security are described in Figure 4.

Environmental risks include impacts on non-target species, disruption of ecosystems, and the development of pesticide resistance. For instance, the toxin derived from the Bt expressed in GM crops affects beneficial insects and leads to the evolution of resistant pests in some cases. GMOs can also potentially crossbreed with wild relatives, leading to gene flow and potential ecological impacts. Resistance management strategies, such as the use of refuges (non-Bt plants within or around the Bt crop field), are essential to delay the evolution of Bt-resistant pests. Such strategies require effective regulation and compliance, as well as education and support for farmers.

From a human health perspective, concerns have been raised about the potential allergenicity or toxicity of GMOs, although to date no substantiated cases of adverse health effects have been documented. Socioeconomic concerns include issues of access and control over GMO technologies and seeds, impacts on smallholder farmers, and implications for agricultural diversity and food sovereignty. Additionally, the dominance of multinational corporations in the GMO seed market and the potential for genetic contamination of non-GMO crops is a concern.

The regulation of GMOs is often intertwined with international trade. The food supply chains should be developed considering international norms and standards as set by the Codex Alimentarius Commission. The regulatory concerns about GMOs involve complex ethical, social, and cultural considerations. For instance, what level of risk is acceptable, and who gets to decide this? How should the benefits and risks of these technologies be distributed? How can the rights of farmers, consumers, and future generations be protected? How can the values and knowledge of local communities be incorporated into the decision-making processes? These are questions that go beyond science alone and touch upon deeper issues of governance, justice, and democracy.

CRISPR technology as an alternative

In contrast to traditional GMOs, some researchers use gene editing technologies, such as CRISPR, to develop crops with desired traits without introducing foreign DNA. These technologies allow precise modifications to a plant's existing genes responsible for yield, resistance to pests or diseases, or tolerance to environmental stresses like drought or salinity. These modifications could be identical to those that might occur naturally or through traditional breeding methods including mutation breeding, thus bypassing controversy and regulatory hurdles associated with GMOs. Researchers have used CRISPR to develop non-browning mushrooms, drought-resistant corn, and wheat resistant to powdery mildew. These crops are not considered GMOs in some jurisdictions because they don't contain foreign DNA. Still, there is an ongoing debate about how these gene-edited organisms should be regulated. Some countries, such as the United States, have decided not to regulate gene-edited crops as long as they don't contain foreign DNA. In contrast, the European Union has ruled that gene-edited organisms should be subject to the same regulations as traditional GMOs, arguing that the process of genetic modification, not just the end product, should be taken into account.

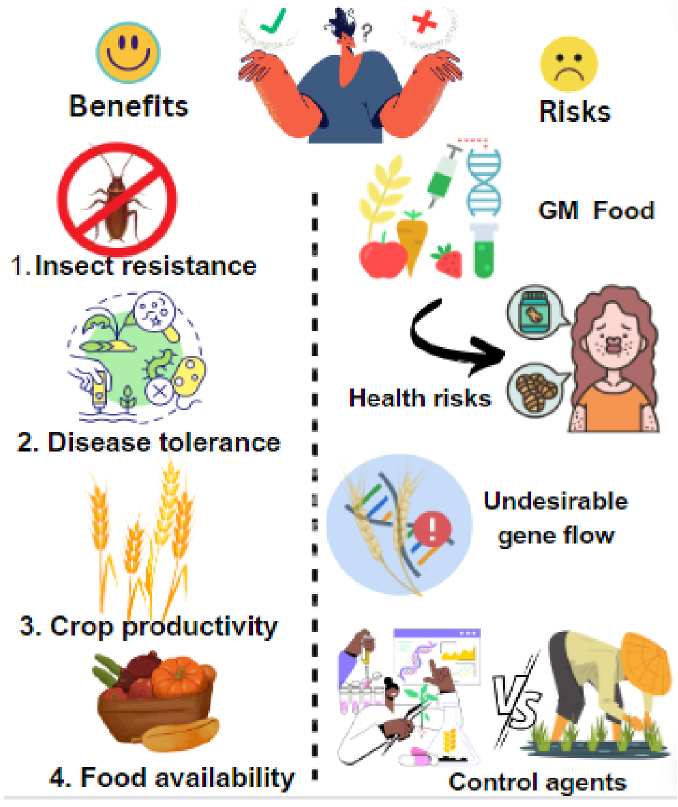

Figure 4: Potential benefits and risks associated with the use of biotechnological tools for food security. A. Potential benefits: enhancing insect and disease resistance, and crop productivity to ultimately develop nutritious food covering all dimensions of food security. B. Potential risks include human health effects from GMO, undesirable gene flow to wild ancestors and insects developing pesticide resistance, and social-economic issues caused by unequal competition between individual farmers and biotechnological companies.

How does CRISPR work?

CRISPR-Cas9, the most commonly used variant of the CRISPR system, functions by precisely cutting the DNA at a specific location in the genome guided by a «guide RNA.» Once the DNA is cut, the cell's own repair machinery fixes the break, often introducing small errors that can disable a gene. Alternatively, a new piece of DNA can be added during the repair process, allowing for the introduction of new genetic material. To develop a non-GMO crop using CRISPR, scientists first identify a target gene or genes that they want to modify. This could be a gene that confers susceptibility to a disease, affects the plant's response to environmental conditions, or influences the quality of the crop. Once the target gene is identified, a guide RNA is designed that matches the sequence of the target gene. This guide RNA is then combined with the Cas9 protein and introduced into plant cells, typically using a technique known as Agrobacterium-mediated transformation or biolistic (also known as «gene gun»). Once inside the cell, the guide RNA directs the Cas9 protein to the target gene, where it makes a precise cut in the DNA. The cell's repair machinery then fixes the break, potentially introducing a mutation that disables the target gene. This approach can be used to create crops with desirable traits without introducing any foreign DNA, thus falling outside of the traditional definition of a GMO.

Examples of Genes Targeted by CRISPR for Non-GMO Production

Crop	Target Gene	Resulting Trait	Reference
Wheat	MLO	Resistance to powdery mildew	Wang et al., 2014
Rice	GS3, DEP1	Increased grain size and yield	Li et al., 2012
Rice	ALS	Herbicide resistance	Li et al., 2016
Maize	LIG1	Male sterility for hybrid seed production	Svitashev et al., 2016
Tomato	SP	Delayed ripening	Ito et al., 2015
Soybean	FAD2	Increased oleic acid content	Haun et al., 2014
Cotton	CLA1	Altered plant architecture	Wang et al., 2018
Potato	VInv	Reduced acrylamide formation	Zhu et al., 2016

Challenges to the biotech centers in OICs

Biotech centers in OIC Member States play a key role in driving biotechnology research and development. However, the number of these centers and their capacity may not be enough, highlighting the need for further investment and capacity building in this field. Currently, Pakistan, Sudan, Bangladesh, Indonesia, Sudan, Egypt, Burkina Faso, etc. are the members of the OIC that are commercially cultivating biotech crops. First evidence of modern biotechnology in Pakistan dates to 1985. As Pakistan signed the Cartagena Protocol on Biosafety, the national biosafety committee was set up in 2005. The first commercial GM plant (Cry1Ac-containing cotton) was licensed in 2010. Since then, 56 advanced biotechnology research institutes have been established. Two pesticide-resistant and pest tolerant corn varieties have also been introduced in 2017. On the contrary, in some member states, the cultivation of GMOs is banned totally by the government or banned by the change of government.

Nonetheless, several OIC member states have recognized the transformative potential of biotechnology for various sectors including agriculture, healthcare, environment, and industry. They established dedicated biotechnology research and development centers, like in Türkiye, Iran, Malaysia, Indonesia, Bangladesh, Saudi Arabia, and Pakistan. Some of the other major biotechnological centers include Iranian Biotechnology Information Center (IrBIC), Atomic Energy Commission and Pakistan Biotechnology Information Center (PABIC), Bangladesh Biotechnology Information Center (BdBIC).

These centers are engaged in a diverse range of activities, from fundamental research to product development and commercialization, as well as policy research and capacity building. Biotech centers, unlike traditional research, face numerous challenges majorly funding issues, especially in the lower-income economies. Biotechnology research and development is a costly endeavor, requiring substantial investment. It's not only limiting the scale and scope of research activities, but also the ability to attract and retain skilled personnel, investment in cutting-edge equipment and facilities, and establish effective linkages with industry and other stakeholders. Also, international engagement including intellectual property rights, technology transfer, access to international funding, collaboration opportunities, and compliance with international standards and regulations are major setbacks.

Another major concern is capacity building and awareness for the responsible use of biotechnologies in crop improvement programs. The development and application of biotechnology requires a highly skilled workforce, including scientists, technicians, and managers, as well as policymakers and regulators who understand the intricacies of biotechnology. According to a report on "agriculture and food security in OIC member countries 2016", the number of agricultural research staff per 100,000 farmers in OIC countries collectively has a higher rate (131), compared to other developing countries (59). However, the ratio of skilled personnel represents uneven distribution across the OIC countries. There should be effective utilization of this highly trained and highly paid staff through even distribution and effective engagement in an enabling environment.

In many OIC countries, regulatory systems for GMOs are either lacking or inadequate. This not only poses risks in terms of safety and environmental impact, but also impedes the development and commercialization of biotechnology products, as investors and consumers may be hesitant to engage with technologies that are not effectively regulated. In 2013, Indonesian Center of Excellence (COE) on Vaccines and Biotechnology Products for OIC member states made itself one of the two countries with WHO prequalified vaccine products. However, to increase public awareness and acceptability, communication and open dialogue to build understanding and trust is needed along with research and product development.

The establishment and functioning of biotech centers in OIC nations are a testament to the potential of scientific and technological progress in addressing food security. However, concerted efforts are needed to address these challenges, ranging from funding and capacity building to regulatory development and public engagement. In this way, the OIC member states can not only participate in the global biotechnology revolution but also shape it to meet their specific needs and aspirations.

Conclusion

The development and application of biotechnology, particularly CRISPR gene-editing technology, in the agriculture sector presents transformative potential for enhancing food security and sustainable development in the OIC Member States. CRISPR has already proven to be a versatile and powerful tool in crop improvement, enabling precise, efficient modifications of crop genomes to confer desirable traits. The gene-edited crops, often created without the incorporation of foreign DNA, challenge the traditional definitions and regulatory frameworks for genetically modified organisms (GMOs). While CRISPR holds great promise, navigating the regulatory landscape remains complex. Each OIC Member State has its own regulatory considerations to address in light of their specific social, economic, and cultural contexts. These include not only ensuring the safety and efficacy of these technologies but also managing their ethical, legal, and socio-economic implications. The case of Bt genes demonstrates the potential benefits and challenges of incorporating biotechnology in agriculture, however, there is a need to address the challenges generated through the introduction of Bt genes. Yet, these developments also raise new regulatory and ethical questions that need to be addressed through robust regulatory frameworks, ongoing research, and transparent, inclusive dialogues. Ultimately, the goal should be to ensure that the benefits of these technologies are widely shared at small farm hold levels. Achieving this will require not only advancements in science and technology but also the cultivation of partnerships, capacity building, and the implementation of policies that are grounded in the principles of precaution, fairness, and respect for diversity and local knowledge.

Recommendations

1. Strengthening and harmonizing the biotechnology regulatory framework among OIC Member States encouraging and ensuring responsible use of biotechnologies for crop improvement.

2. Capacity building in biotechnology research and development in OIC member countries.

3. Fostering international collaboration and partnership in biotechnology research and development.

4. Public awareness and dialogue on the benefits and risks of biotechnology.

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EN **SUMMARY**

Biotechnology, Food Security, and Regulatory Concerns in OIC Member States: Prospects and Challenges

This paper explores the intersection of biotechnology, food security, and regulatory concerns within the geography of the Organization of Islamic Cooperation (OIC). With increasing global population and climate change, food security has become an urgent priority for OIC nations. Advances in biotechnology, like Genetically Modified Organisms (GMOs) and Clustered Regularly Interspaced Short Palindromic Repeats (CRISPR) technology, present significant opportunities for enhancing food security. However, these technologies also raise ethical, environmental, and health-related concerns. This paper explores the potential of biotechnology to address food security, biotech centers within OIC member states, the regulatory concerns surrounding GMOs and CRISPR technologies, and the promise and controversy of Bt genes. It seeks to outline a balanced perspective, acknowledging the immense potential of these technologies for improving agricultural productivity and sustainability, while also highlighting the need for comprehensive regulatory frameworks and public dialogue to address potential risks. The discussion will foster further research in the area of biotechnology for better policy making within OIC member states.

FR **RÉSUMÉ**

Biotechnologie, Sécurité alimentaire et Préoccupations réglementaires dans les États Membres de l'OCI : perspectives et défis

Cet article explore l'intersection de la biotechnologie, de la sécurité alimentaire et des préoccupations réglementaires dans la géographie de l'Organisation de la Coopération Islamique (OCI). Avec l'augmentation de la population mondiale et le changement climatique, la sécurité alimentaire est devenue une priorité urgente pour les pays de l'OCI. Les progrès de la biotechnologie, comme les organismes génétiquement modifiés (OGM) et la technologie des Courtes répétitions palindromiques groupées et régulièrement espacées (CRISPR), présentent des opportunités importantes pour améliorer la sécurité alimentaire. Cependant, ces technologies soulèvent également des préoccupations éthiques, environnementales et sanitaires. Cet article explore le potentiel de la biotechnologie pour aborder la sécurité alimentaire, les centres de biotechnologie dans les États Membres de l'OCI, les préoccupations réglementaires entourant les OGM et les technologies CRISPR, ainsi que la promesse et la controverse des gènes Bt. Il cherche à définir une perspective équilibrée, reconnaissant l'immense potentiel de ces technologies pour améliorer la productivité et la durabilité agricoles, tout en soulignant la nécessité de cadres réglementaires complets et d'un dialogue public pour faire face aux risques potentiels. La discussion favorisera de nouvelles recherches dans le domaine de la biotechnologie pour une meilleure élaboration des politiques au sein des États Membres de l'OCI.

AR **ملخص**

التكنولوجيا الحيوية والأمن الغذائي والمخاوف التنظيمية في الدول الأعضاء في منظمة التعاون الإسلامي: الآفاق والتحديات

تستكشف هذه الورقة تقاطع التكنولوجيا الحيوية والأمن الغذائي والمخاوف التنظيمية ضمن جغرافية منظمة التعاون الإسلامي (OIC). مع تزايد عدد سكان العالم وتغير المناخ ، أصبح الأمن الغذائي أولوية ملحة لدول منظمة التعاون الإسلامي. تقدم التطورات في التكنولوجيا الحيوية ، مثل الكائنات المعدلة وراثيًا (GMOs) وتكنولوجيا التكرارات القصيرة المتناظرة المتباعدة بانتظام (CRISPR) ، فرصًا كبيرة لتعزيز الأمن الغذائي. ومع ذلك ، فإن هذه التقنيات تثير أيضًا مخاوف أخلاقية وبيئية وصحية. تستكشف هذه الورقة إمكانات التكنولوجيا الحيوية لمعالجة الأمن الغذائي ، ومراكز التكنولوجيا الحيوية داخل الدول الأعضاء في منظمة التعاون الإسلامي ، والظروف التنظيمية المحيطة بالكائنات المعدلة وراثيًا وتقنيات كريسبر ، والوعد والجدل المتعلق بجينات Bt. ويسعى إلى تحديد منظور متوازن ، مع الاعتراف بالإمكانيات الهائلة لهذه التقنيات لتحسين الإنتاجية الزراعية والاستدامة ، مع إبراز الحاجة إلى أطر تنظيمية شاملة وحوار عام لمواجهة المخاطر المحتملة. ستعزز المناقشة مزيدًا من البحث في مجال التكنولوجيا الحيوية من أجل صنع سياسة أفضل داخل الدول الأعضاء في منظمة التعاون الإسلامي.

UPSCALING PLANT BREEDING FROM TRADITIONAL TO GENOMIC SELECTION IN KAZAKHSTAN

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Introduction

WHEAT YIELD AND PRODUCTION AROUND THE GLOBE AND IN KAZAKHSTAN

Bread wheat (*Triticum aestivum*) is one of the most adaptable and widely grown cereal crops across the world for food as well as feed. Global wheat production and yield increased significantly in the last decade, despite the decline of its grown area (Figure 1 and Figure 2).

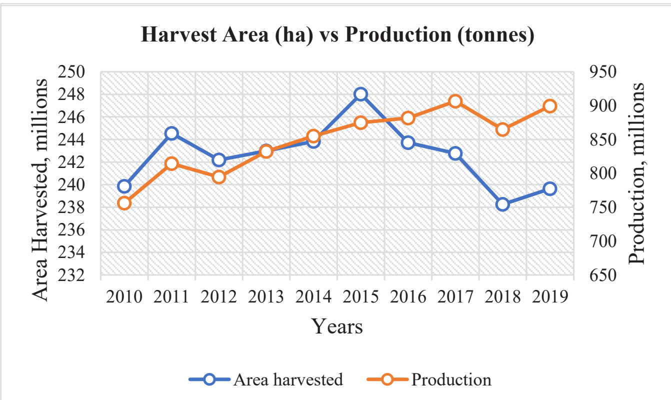

Figure 1 Global Wheat Harvested area and Production
The figure demonstrates that although the global wheat harvested area has shrunken, its overall production has increased.Data source: FAOSTAT

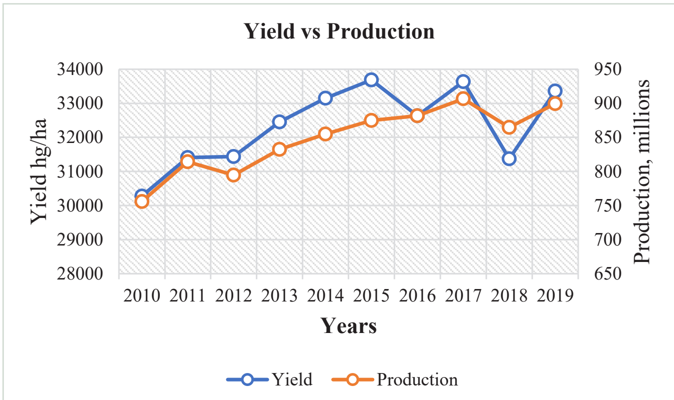

Figure 2 An average Global Wheat Grain Yield and Production
The global production of wheat increased mainly due to increased grain yield per hectare Data source: FAOSTAT

However, the trend has not changed in Kazakhstan since the 1990s (Figure 3 and Figure 5). The country has not seen a significant yield increase since the reclamation of fallow land in the 1960s (data not shown). The average wheat yield in the country could reach 1.6 t/ha, reaching a minimum of 0.5 t/ha in the worst scenario compared with the global average (Figure 5). Pearson's correlation was found despite a significant but weak among the sowing area and total production in the country (Figure 4). This indicates yield dependency on environmental changes. Conversely, there is a high consistency between the average yield and total production (Figure 6). As Kazakhstan is one of the main wheat grain providers globally, volatile wheat production poses a significant threat to global, as well as regional food security. Thus, long-term systematic wheat breeding programs with the use of current advanced technologies and techniques may assist to overcome the existing problems.

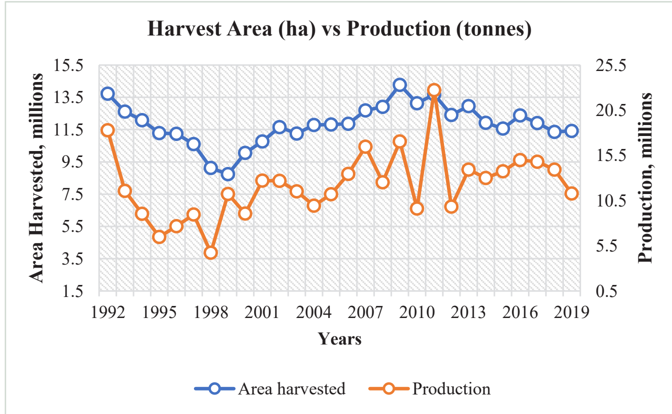

Figure 3 Wheat Harvested area and Production in Kazakhstan
The table shows an increase in wheat sowing area in Kazakhstan does not always correlate with an increased grain yield, proving strong environmental effects on an average and overall grain yield. Data source: FAOSTAT

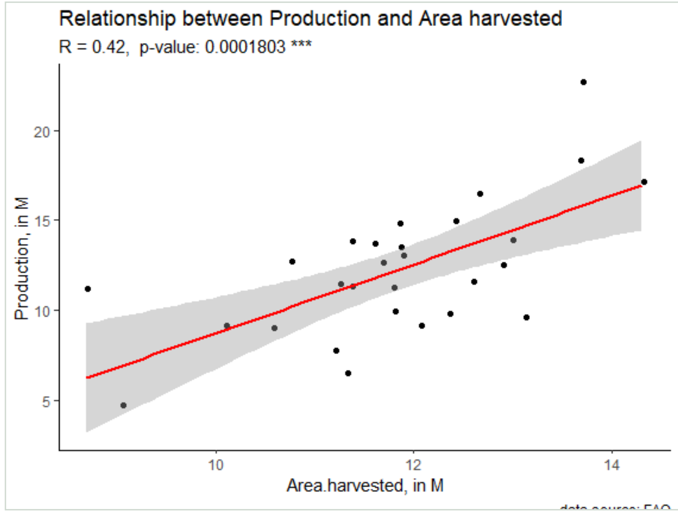

Figure 4 Wheat Total Production vs Area Harvested in Kazakhstan
Although correlation between sowing area and total production in the country was significant, Pearson's correlation coefficient was not that strong. Data source: FAOSTAT

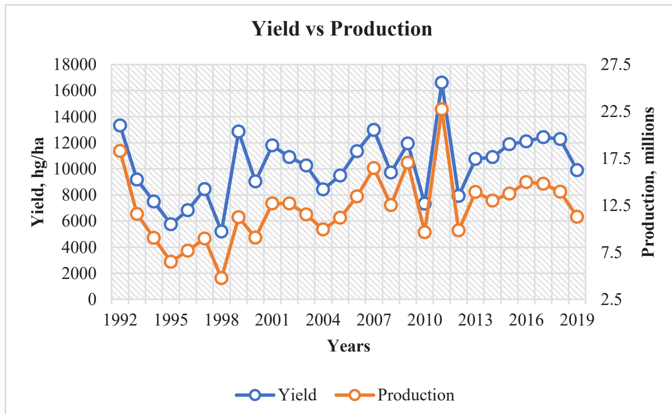

Figure 5 An average Wheat Grain Yield and Production in Kazakhstan
The figure shows that overall wheat production in Kazakhstan is mainly determined by an average yield. Data source: FAOSTAT

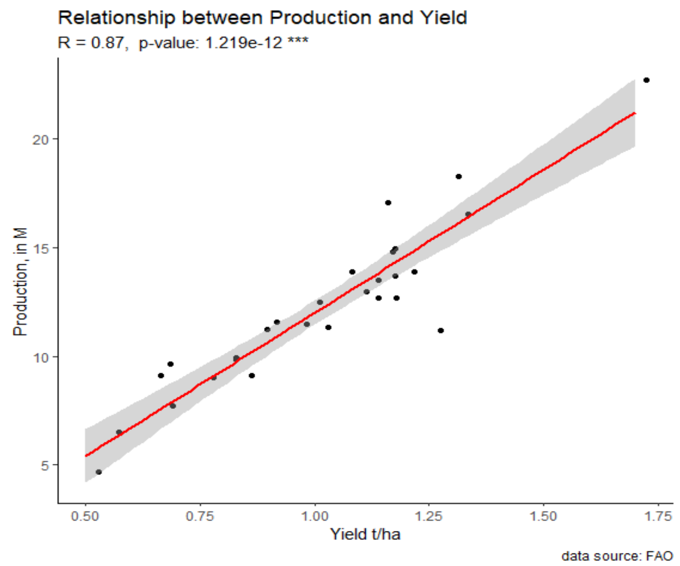

Figure 6 Wheat Total Production vs Average Yield in Kazakhstan
Pearson's correlation coefficient between the total production and average yield in Kazakhstan was strong compared to the correlation between total production and wheat harvested area.

The role of Kazakhstan in a global market

Wheat ranks 85th place among the world's most traded commodities, with a total trade of $44.1B, which makes it one of the important staple crops. In a global ranking of wheat exports and imports, Russia became the top exporter of wheat in recent years and Egypt remains the top importer. Kazakhstan, despite unstable grain production, plays a significant role in contributing to current and future global food security and is known as one of the major wheat suppliers of the world. Kazakhstan's share in global wheat exports among top exporters (Figure 7) accounted for about 1.5% at the minimum and 3.2% at the maximum with a mean of ~2.35%, depending on the season, in the last decade (www.oec.world).

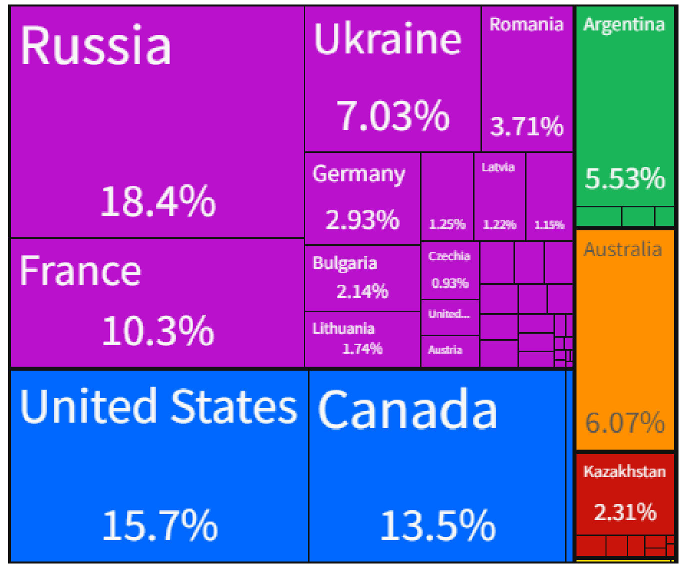

Figure 7 The world's topmost wheat exporters
Each country's contribution is shown as a percentage of the total. Data source: (www.oec.world). The purple, blue, green, orange, red and yellow colour coding represents European, South American, North American, Australia, Asian and African countries respectively. Data for the year 2019.

Most of the time, one half of its harvested wheat is exported for external use. The topmost consumers of Kazakh bread wheat are OIC countries. However, the high quality of Kazakhstani wheat attracts China and some European countries as well (Figure 8).

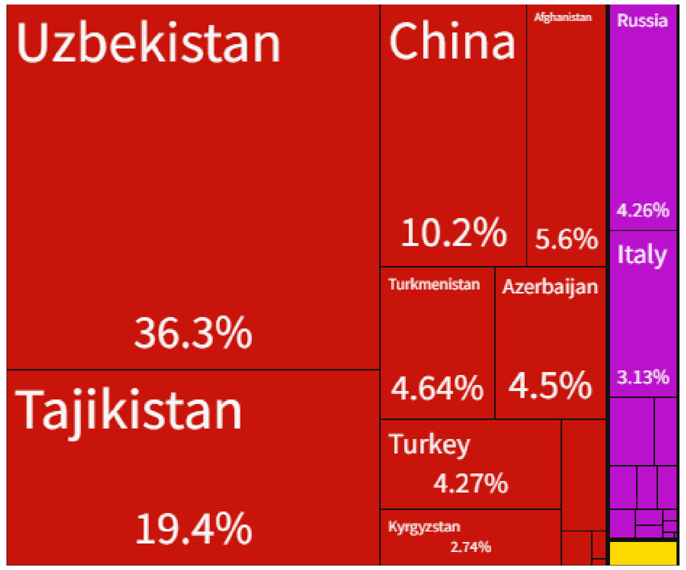

Figure 8 The list of top customers of the Kazakh bread wheat
The figure presents top Kazakh wheat consumers. Data source: (www.oec.world). The red, purple, and yellow colour coding represent Asian, European and African countries respectively. Data for the year 2019.

Overview to the next generation plant breeding methodologies and their potential use in Kazakhstan

The burst of new generation breeding tools has greatly alleviated the labour-intensive long-lasting solo phenotype-based traditional plant breeding. It also allowed scientists to understand the functions of genes of agronomic importance. Thus, modern molecular genetics, genomics and bioinformatics methods combined with conventional breeding methodologies are a powerful way to see the desired gene/s in the breeder's favourite variety within a short time. Recently emerged new phenomics and genomics approaches, such as speed breeding, allow up to six generations of many crops in a year (Cha et al. 2021; Watson et al. 2018) and accelerated gene cloning approaches such as map-based cloning (Munoz-Amatriain et al. 2011), RNA-seq approach (Chen et al. 2021; Habib et al. 2018), next-generation sequencing (Bhat and Yu 2021; Zhong et al. 2018), GWAS (Juliana et al. 2018), MutChromSeq (Sanchez-Martin et al. 2016), MutRenSeq (Steuernagel et al., 2016), sequence assembly based AgRenSeq (Arora et al. 2019), bulked segregant exome capture sequencing, BSE Seq (Dong et al. 2020) and competitive allele-specific PCR known as KASP genotyping (He et al., 2014) have simplified old laborious methods and reduced the cost and time required. However, all these methods require the knowledge of databases, understanding and sequencing data management. Moreover, these gene cloning and validation approaches have to be employed based on the aim of the study and the type of research material being used. A direct genome editing tool, CRISPR-Cas9 (Cao et al. 2016; Zhang et al. 2020) and high-throughput phenotyping planforms empowered by GPS (Crain et al. 2018; Song et al. 2021) and temperature, humidity, and light sensors, able to monitor the plant throughout its life cycle (Gewin 2017; Zhou et al. 2017) are other methodologies which promise benefits in future plant breeding. Moreover, international cooperation plays a significant role in understanding plant adaptation better, as it provides breeders and researchers with an opportunity to share their knowledge and experiences, and wheat with various agro-ecological niches to be tested. So far, we developed first- and second-generation mapping populations for Kazakh bread wheat with the collaboration of John Innes Centre (JIC), UK and the Institute of Plant Biology and Biotechnology (IPBB), Kazakhstan. Several QTLs associated with significant agronomic traits have been identified (Amalova et al, 2022). In Kazakhstan, several crop species have been genotyped with various sets of molecular markers. However, the obtained wealth of genetic information has not been properly captured to intensify breeding programs yet. To address these issues, we have adapted KASP technology at the Zhetysu University and are trying to understand the isogenic background of different QTLs to harness their economic potential. Thus, we pioneered the efforts to quantify genetic components of Kazakh bread wheat which might be associated with essential agronomic characteristics.

Conclusion

Kazakhstan possesses a colossal agricultural capacity. Among crops grown in the country, wheat remains an important food resource. However, local wheat breeding schemes have not taken full advantage of genomic selection. Compared to conservative plant breeding methods, such modern approaches could potentially shorten the duration of releasing new crop varieties with improved yield, quality and adaptation. Therefore, traditional plant breeding practices in the country should successfully be coupled with genomic selection to intensify breeding programmes. Currently, we attempt to quantify the genetic components of Kazakh bread wheat which might be associated with essential agronomic characteristics using both population and quantitative genetics.

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EN SUMMARY

Upscaling plant breeding from traditional to genomic selection in Kazakhstan

Kazakhstan occupies 272 M hectares, which makes it ninth largest country across the world. The country has huge agricultural capacity, but unfortunately is not being deployed properly. Nevertheless, wheat cultivation and productivity remains on top of the country's agricultural agenda. Almost half of the arable land, ~12 million hectares, produce 15-20 M tonnes wheat, half of which is exported. Despite a large production area, average wheat of 1 t/ha remained constant since the 1960s. The crop improvement programs majorly rely on traditional breeding methods in the country. There is a need to manipulate final grain quality and yield via improving genetic potential and resilience to stress using advanced breeding approaches.

FR RÉSUMÉ

Le Kazakhstan devrait donner la priorité à des stratégies appropriées pour faire passer la sélection végétale de la sélection traditionnelle à la sélection génomique.

Le Kazakhstan occupe près de 272 millions d'hectares, ce qui en fait le neuvième plus grand pays du monde. Sa capacité agricole est donc colossale, mais elle n'est malheureusement pas exploitée correctement. Néanmoins, la culture et la production de blé restent en tête des priorités agricoles du pays. Près de la moitié des terres arables, soit environ 12 millions d'hectares, sont utilisées pour assurer une production totale de blé de 15 à 20 millions de tonnes, dont la moitié est destinée à l'exportation. Toutefois, le rendement moyen du blé n'a pas changé depuis les années 1960 et est resté inchangé à environ 1 t/h. En outre, la quasi-totalité du programme de sélection végétale du pays repose essentiellement sur des méthodes traditionnelles. Il est donc temps d'essayer de manipuler la qualité finale des grains et le rendement en améliorant le potentiel génétique et la résistance au stress à l'aide d'approches de sélection avancées.

AR ملخص

ضرورة إعطاء الأولوية للاستراتيجيات المناسبة لتحويل تربية النباتات من الانتقاء التقليدي إلى الانتقاء الجيني في كازاخستان

نظرًا لحقيقة أن كازاخستان تتمتع ما يقرب من 272 مليون هكتار من الأراضي والتي تجعلها تاسع أكبر دولة في جميع أنحاء العالم، فإن قدرتها الزراعية هائلة، ولكن للأسف لا يتم نشرها بشكل صحيح. ومع ذلك، فلا تزال زراعة القمح وإنتاجه على رأس جدول الأعمال الزراعي للبلاد. حيث يتم استخدام ما يقرب من نصف الأراضي الصالحة للزراعة، أي حوالي 12 مليون هكتار، لتلبية حوالي 20-15 مليون طن من إجمالي إنتاج القمح، ونصفها للتصدير. ومع ذلك، فلم يتغير معدل محصول القمح منذ الستينيات وظل دون تغيير بحوالي 1 طن في الساعة. علاوة على ذلك، يعتمد مُعظم أجزاء مخطط تربية النباتات بالكامل تقريبًا في البلاد على الطرق التقليدية. بالتالي، فلقد حان الوقت لمحاولة التحكم في جودة الحبوب النهائية والمحصول من خلال تحسين الإمكانات الجينية والمرونة في مواجهة الإجهاد باستخدام أساليب التربية المتقدمة.

TRANSFORMING PLANT GROWTH AND DISEASE MANAGEMENT USING MICROBIOME TECHNOLOGIES IN RICE

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Pest and Disease Management: Exploring microbiomes

Pest control and disease management are critical aspects of rice cultivation, ensuring optimal yields and sustainable production. Integrated approaches, such as Integrated Pest Management (IPM), biological control, preventive measures, and reduced pesticide use, are employed to effectively control pests and diseases in rice fields. Biological control technology is, however, hampered by the lack of understanding in soil and plant microbiomes. The reductionist (bottom-up) and holistic (top-down) approaches are currently used to understand the soil and plant microbiome. The former involves studying individual microbial species or strains at a molecular level to understand their functions, interactions, and behaviors. The latter focuses on analyzing the entire microbial community as a complex system to understand community-wide functions and dynamics.

Engineering Beneficial Synthetic Microbial Communities (SynComs) for Disease Control in Rice

Efforts are underway in our laboratory to develop beneficial synthetic microbial communities (SynComs) for plant disease control using both reductionist and holistic approaches. SynComs mimic natural microbiomes and involve creating a community of multiple microbial species capable of performing complex functions, such as disease control and nutrient cycling. Figure 1 represents the current experimental framework employed in our laboratory for the selection of SynComs tailored for agricultural applications, with a specific focus on rice cultivation as a model system.

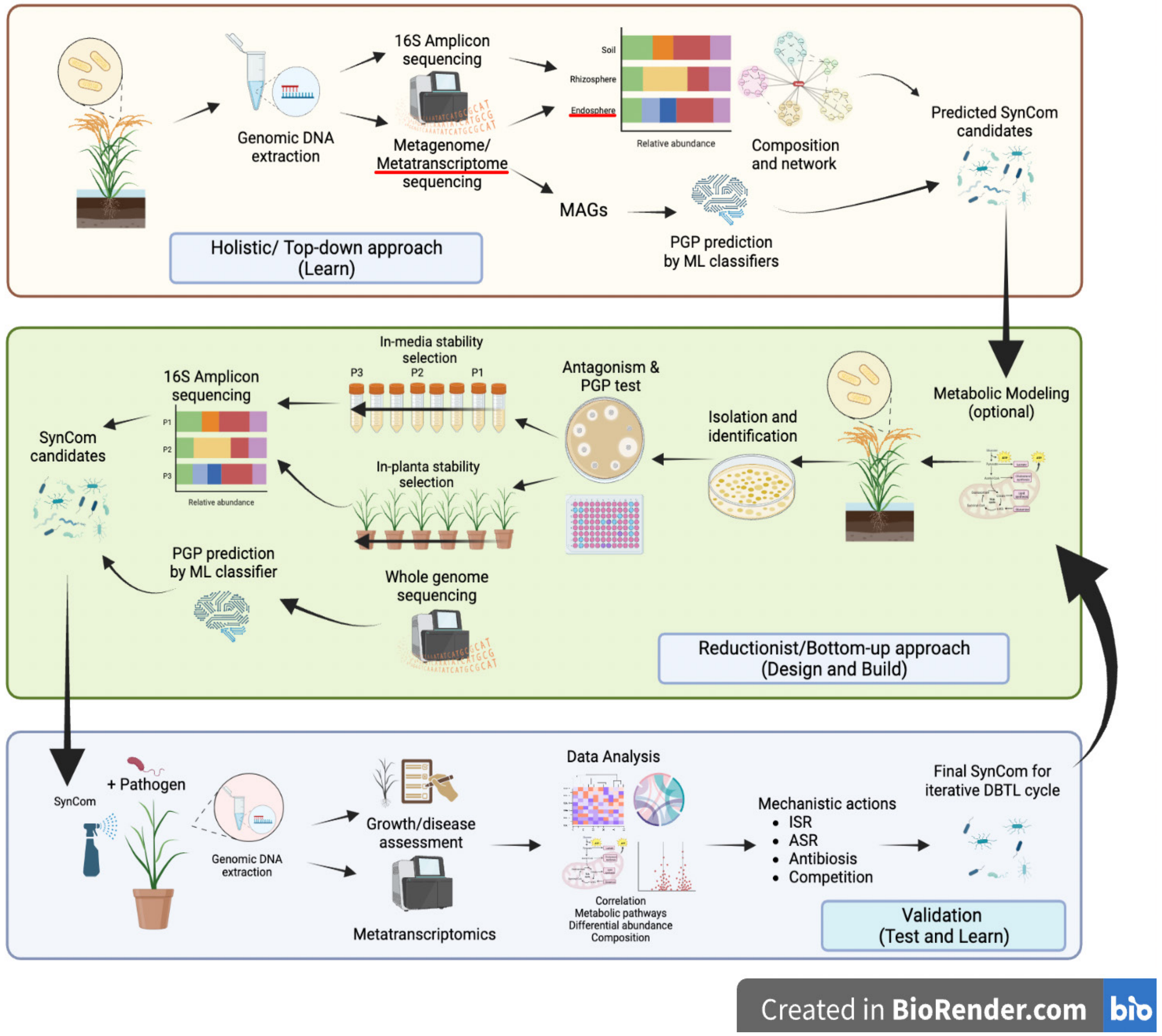


Figure1: Experimental framework for SynCom selection: Current laboratory approach

Utilizing reductionist approaches, we have isolated bacterial strains with biocontrol properties against blight-causing pathogens in rice. Figure 2 shows bacterial isolation, agar well diffusion assay of selected isolates against the causal agent of blight disease, *Xanthomonas oryzae* pv. *oryzae* and *Pantoea ananatis*, and detached leaf assays using rice leaves. However, the reductionist process can be cumbersome and time-consuming due to the extensive testing of numerous combinations and the random selection required. To improve the selection process and facilitate data-driven decision-making, we aim to integrate a top-down approach, utilizing metatranscriptomics or 16S/metagenomics in our pipeline. This approach enhances our understanding of the microbiome and reduces the time and effort required for the process. Metabolic modeling, genomics (whole genome sequencing), metatranscriptomics, are also utilized to predict microbial community responses, identify key taxa, genes and functional modules involved in disease control, and optimize microbial consortia selection and design.

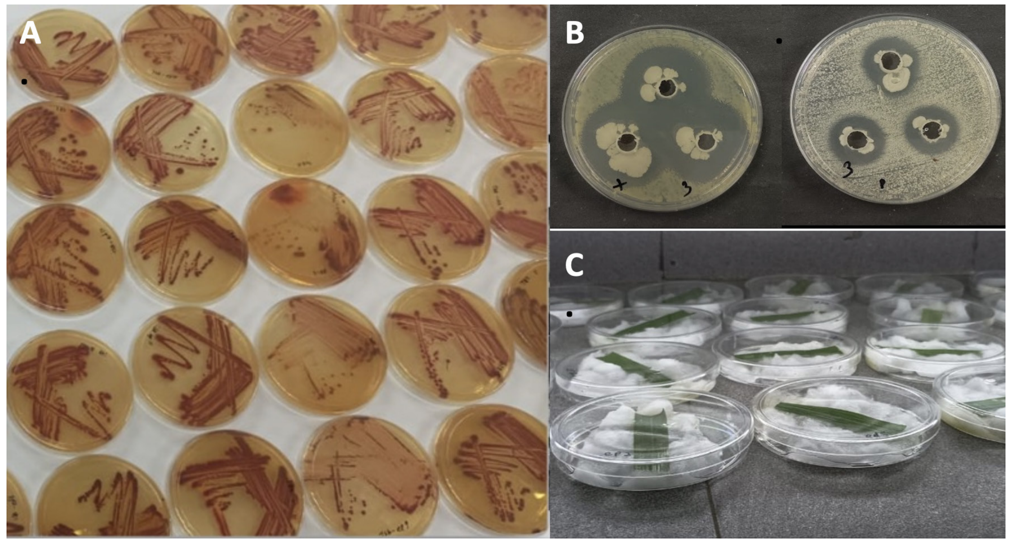


Figure 2: A. Isolation of bacteria from rice rhizosphere, phyllosphere and rice grains. B. Agar well diffusion of a positive isolate against Xanthomonas oryazae pv oryzae, and Pantoea ananatis. C. Detached leaf assay

Furthermore, we employ artificial intelligence (AI) and build machine learning (ML) models to analyze microbiome datasets and aid in the selection of synthetic communities. Of all ML algorithms tested, Random Forest classifier, an ensemble ML model, was the best classifier in predicting three classes; PGP-associated, plant pathogenic, and non-PGP associated bacterial genomes. The classifier is used on bacterial genomes data to identify potential pathogens, enabling us to detect and eliminate undesirable strains from inclusion in the SynComs at an early stage.

Continuous Improvements in Microbial Consortia Design

Integrating metabolic modeling, machine learning, metatranscriptomics, and genomic analysis offers promising opportunities to improve the design and predictions of microbial community behavior, leading to the development of more effective microbial consortia for pest control and disease management in rice cultivation.

In our pursuit to create effective SynComs for diverse environmental conditions, we adopted the DBTL (Design, Build, Test, and Learn) framework (Figure 3) that has been widely used to engineer complex systems for various applications including engineering, computer science and biotechnology. This framework prioritizes continuous improvement and iterative development of SynCom formulations. We selected microbial strains based on their metabolic capabilities and desired functions as provided by genomics, metatranscriptomics and metabolic modeling (Design). Subsequently, we constructed the SynCom formulation by co-culturing multiple taxa under controlled conditions to emulate the structure and functionality of a microbiome (Build). Rigorous testing on plants enabled us to validate and evaluate how the designed SynCom formulation influences plant metabolism and physiology (Test). Through this testing phase, we gained valuable information on the performance and effectiveness of SynComs under various environmental conditions (Learn). This knowledge guides us in refining and optimizing the formulation to enhance disease management and foster plant health. Therefore, by iteratively implementing the DBTL cycle, we can hopefully develop SynComs that are increasingly effective and tailored to specific disease management requirements and environmental conditions.

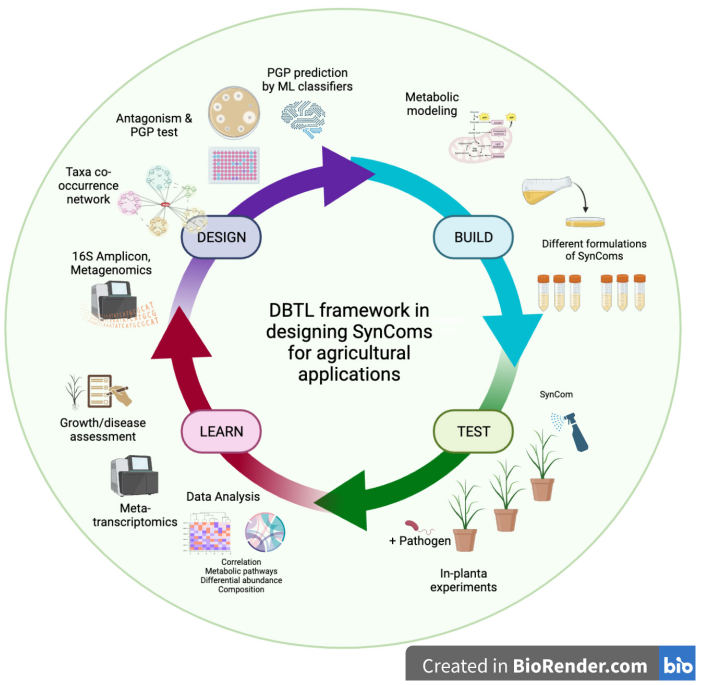


Figure 3: Design-Build-Test-Learn Framework for continuous improvement and iterative development of SynCom formulations to facilitate plant growth and disease management.

Navigating the Challenges of Designing Effective SynComs for Disease Management in Agriculture

Designing effective SynComs for disease management in agriculture is challenging due to microbial complexity and the need for a comprehensive understanding of microbial physiology and ecology. Successful SynComs depend on synergistic interactions and stable community dynamics. Ensuring long-term storage, media stability, and persistence in the agricultural environment remains a significant challenge. Metabolic modeling, in-media stability, and in-planta stability assessment of the SynCom as depicted in Figure 3 is necessary to address these challenges.

Developing optimal SynComs involves customizing microbial communities based on host plants, target pathogens, and environmental conditions. Scaling up SynCom designs from lab to field applications presents challenges in implementation, establishment, and evaluation at larger scales. Cost-effectiveness, practicality, and regulatory compliance are crucial considerations for widespread adoption in agriculture. We prioritize safety by excluding potentially harmful strains through PCR-based detection of virulent genes and conducting toxicity tests using blood agar.

Towards a Greener and Safer World: Enhancing SynCom Technologies

To exploit the potential of SynCom technologies, increased investments and strategic actions are needed for a greener and safer world, especially in countries with low fertility soil like OIC member states. Funding for research and development should be prioritized, enabling the acquisition of advanced equipment like DNA sequencers and powerful computing systems for studying microbial communities. It is essential to train and equip a larger workforce with relevant expertise in applying SynCom technologies in agriculture. Rigorous field trials and data collection across different locations are crucial for improving computational models and prediction accuracy. Collaborative efforts and data sharing among OIC countries can enhance resource pooling and knowledge exchange. Governments should also establish robust policy frameworks that incentivize companies to adopt environmentally friendly practices, promoting the growth of sustainable and high-quality products. Thus, we can lay the foundation for a sustainable future, safeguarding food security, environmental conservation, and the well-being of future generations.

EN SUMMARY

Transforming plant growth and disease management using microbiome technologies

Adopting inclusive approaches for better understanding of agricultural problems is crucial. We emphasize the importance of data-driven selection of beneficial Synthetic Communities (SynComs) to address pests and diseases, in contrast to conventional testing approaches. The research proposes integrating reductionist and holistic approaches, employing meta-transcriptomics and machine learning for selection, and implementing the Design-Build-Test-Learn (DBTL) framework for development of SynCom formulations to facilitate plant growth and disease management in rice as a model crop. The significance of tackling challenges related to storage, stability, scalability, regulatory compliance, and safety is highlighted. The goal is to enhance SynCom technologies for sustainable agriculture, ensuring food security and environmental preservation.

FR RÉSUMÉ

Transformer la croissance des plantes et la gestion des maladies grâce aux technologies du microbiome

L'adoption de technologies pertinentes est essentielle pour acquérir une compréhension globale des problèmes agricoles. Nous soulignons l'importance d'une sélection des SynComs fondée sur les données pour lutter contre les ravageurs et les maladies, contrairement aux approches conventionnelles de tests aléatoires et non fondés sur les données. Nous proposons d'intégrer des approches réductionnistes et holistiques, d'utiliser la métatranscriptomique et l'apprentissage automatique pour la sélection, et de mettre en œuvre le cadre Design-Build-Test-Learn (DBTL). Nous soulignons l'importance de relever les défis liés au stockage, à la stabilité, à l'évolutivité, à la conformité réglementaire et à la sécurité. L'objectif final est d'améliorer les technologies SynCom pour une agriculture durable, garantissant la sécurité alimentaire et la préservation de l'environnement.

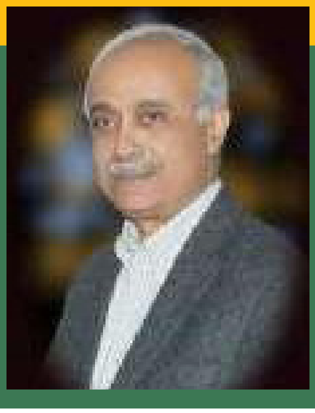
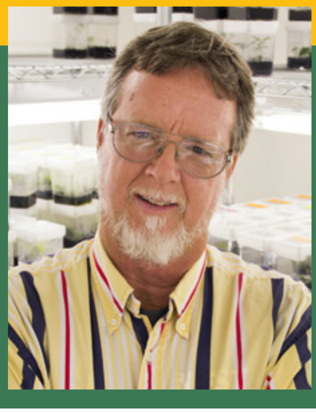
AR ملخص

. تحويل نمو النبات وإدارة الأمراض باستخدام تقنيات الميكروبيوم

يُعد اعتماد التقنيات ذات الصلة أمرًا بالغ الأهمية لاكتساب فهم شامل للمشاكل الزراعية. ونؤكد على أهمية اختيار SynComs المستند إلى البيانات لمعالجة الآفات والأمراض، على عكس نُهج الاختبار التقليدية غير القائمة على البيانات والاختبارات العشوائية. ونقترح دمج الأساليب الاختزالية والشاملة، واستخدام metatranscriptomics والتعلم الآلي للاختيار، وتنفيذ إطار (Design-BuildTest-Learn (DBTL. كما تم تسليط الضوء على أهمية معالجة التحديات المتعلقة بالتخزين والاستقرار وقابلية التوسع والامتثال التنظيمي والسلامة. ويتمثل الهدف النهائي في تعزيز تقنيات SynCom للزراعة المستدامة، وضمان الأمن الغذائي والحفاظ على البيئة.

NOVEL SOMATIC HYBRIDS AND AUTOTETRAPLOID BREEDING PARENTS FOR CITRUS SCION IMPROVEMENT

SADAF ALTAF, IQRAR AHMAD KHAN, MUHAMMAD JAFAR JASKANI, JUDE GROSSER AND BUSHRA SADIA

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Key Words: Protoplasts, Cybrids, ESTSSRs, Somatic Hybids

Introduction

Food security and sustainable agriculture have emerged as key issues worldwide under changing climate and increasing global population. The rapidly growing population demands proficient crop improvement for enhancing yield and quality to serve the ever- increasing food needs. However, the century old conventional breeding methods have proven to be less efficient to meet these needs. The tools of biotechnology have facilitated the engineering of desired traits into plants with accuracy, and accelerate genetic manipulation of crops. Biotechnological methods such as somatic hybridization via protoplast fusion, genetic engineering, marker assisted selection, structural and functional genomics, bioinformatics, and genome editing possess a number of advantages over conventional breeding techniques.

Somatic hybridization involves in vitro isolation of wall-less cells (protoplasts) of two closely-related to distantly-related plant species of the same or different genera/ families, their fusion and subsequent regeneration into the somatic hybrid (SH) plants. This technique bypasses sexual incompatibility barriers, transfers the desired traits into the somatic hybrids without inserting foreign DNA and hence, facilitates conventional breeding through creation of the novel germplasm. These novel variations appear due to segregation of mixed organelles, cytoplasmic and nuclear gene recombination, and somaclonal variation and hence broaden the genetic base of cultivated species. The pre- basics for successful exploitation of this technique are listed in Figure 1.

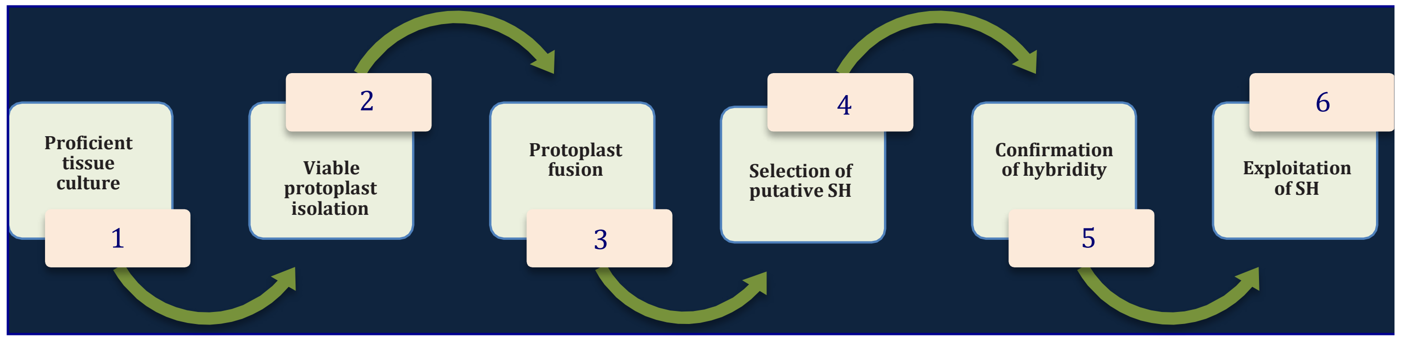

Figure 1. The basic steps involved in Somatic hybridization technique. SH: somatic hybrids

These somatic hybrids may have either exact chromosomal complement of both the fusing protoplasts (symmetric hybrids) or varying chromosomal constitution than the parental protoplasts (asymmetric hybrids). Symmetric hybrids may contain undesirable traits along with the desired ones, leading to fertility or complete sterility.

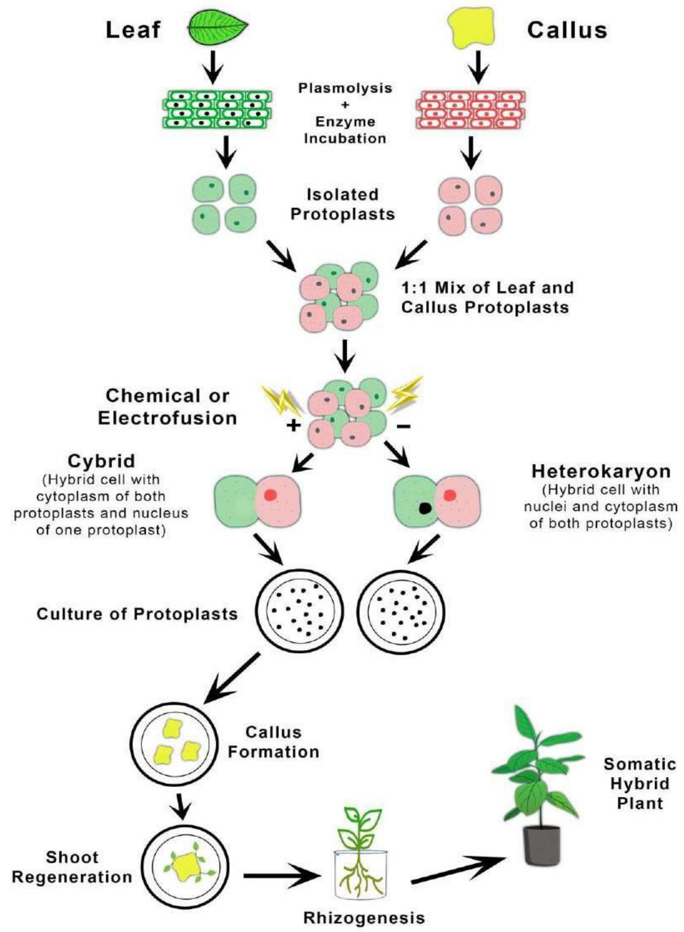

Figure 2. Somatic hybridization protocol

Partial genome transfer of donor protoplasts using asymmetric somatic hybridization may overcome this disadvantage. Currently, somatic hybrids have been produced in hundreds of plant species including potato, tomato, wheat, rice, oat, maize, brassicas, sorghum, and citrus, etc.

CITRUS PRODUCTION CHALLENGES

The potential of genetic improvement is of great interest to breeders and growers of woody fruit plants. Citrus is one of the most popular fruits grown from subtropical to tropical and Mediterranean regions of the world. According to the WCO, the world's citrus output reached 158.5 million metric tons during the summer 2021 and winter 2021/22 citrus seasons. China leads the world's production with its volumes amounting to 44.6 million metric tons and accounting for 28% of the global output. It is followed by Brazil and India, with 12% and 9%, respectively. While 51% of all citrus is produced in Asia, 52% of citrus exports originate from the Mediterranean region, with the major share from Spain, South Africa, Turkey and Egypt (https://www.producereport.com).

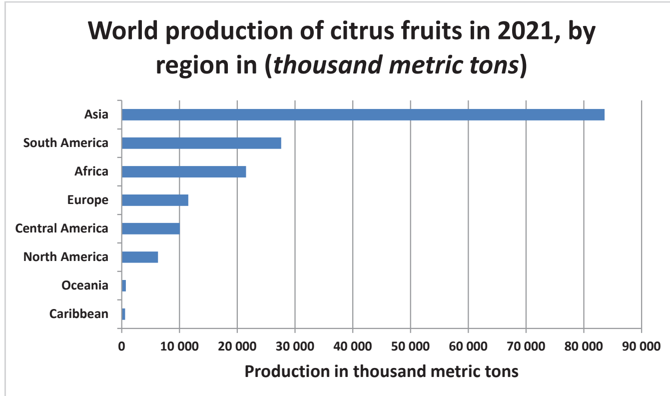

Figure 3. World production of citrus fruits in 2021, by region (in thousand metric tons (https://www.statista.com)

The USDA's foreign Agricultural Service forecasted decreased global production in all categories of citrus in the 2022/ 23 season. The production challenges to Citriculture include incidence of pests and diseases, competitive international markets and climate change- related abiotic stresses. Developing cultivars with diverse features of consumer choice, improving fruit quality traits, and speedy varietal release, are key breeding objectives of citrus. Citrus breeders and growers are concentrating their efforts on developing climate smart varieties. However, narrow genetic base in Citrus germplasm, along with the quantitative nature of majority of agronomic traits, polyembryony, pollen–ovule sterility, sexual and graft incompatibilities, and extended juvenility have made conventional breeding time-consuming and expensive, which compromises its efficacy as a strategy for citrus cultivar development and improvement.

SOLUTION

Among various existing biotechnological advancements, somatic hybridization via protoplast fusion, offers a viable alternative to traditional approaches of citrus improvement. The main goal of citrus scion and rootstock improvement based on somatic hybridization is to create allotetraploid somatic hybrids between parents that possess complementary characteristics. This technique has been used up to its full potential in citrus and has become an integral part of citrus breeding programs worldwide (Figure 4).

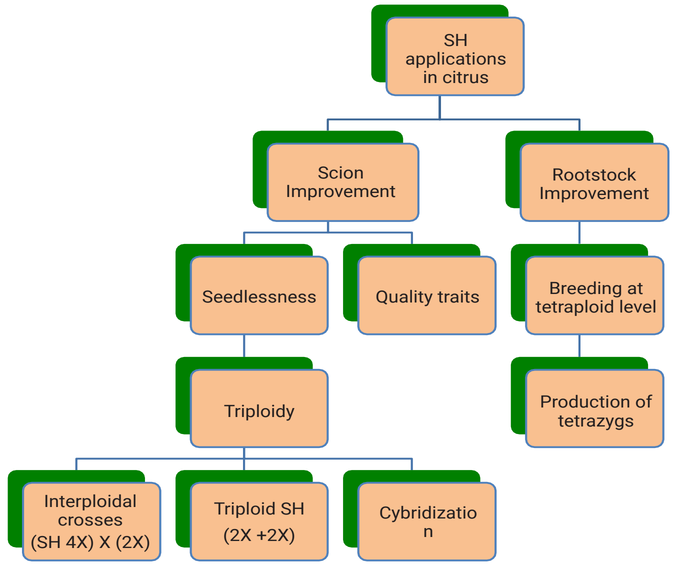

Figure 4. Exploitation of Somatic hybridization in citrus

CITRUS SOMATIC HYBRIDIZATION

The protoplast fusions of two mandarin cultivars, W Murcott (C. reticulata Blanco x C. sinensis Osbeck) + Snack mandarin (C. reticulata Blanco x C. sinensis Osbeck) were performed via PEG-mediated method in different parental combinations following different steps:

OPTIMIZING CITRUS IN VITRO CULTURE

Reproducible tissue culture protocols of two citrus varieties were established (Figure 5 and 6). The protoplasts of citrus variety W Murcott were isolated from cell suspension cultures and those of Snack mandarin were isolated from leaf explants obtained from in vitro- regenerated seedlings (Figure 7). Somatic hybridization was performed by fusing cell suspension protoplasts of W Murcott with leaf protoplasts of Snack mandarin via PEG- mediated fusion method (Figure 8). Fusion products were cultured in liquid medium, underwent somatic embryogenesis, and produced putative hybrid shoots. These were rooted into complete putative somatic hybrid plants (Figure 9).

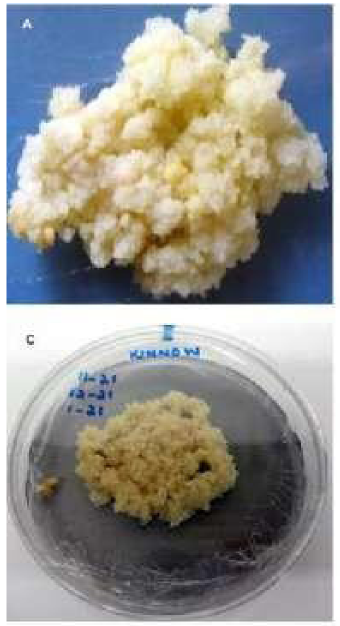

Figure 5. Initiation of callus cultures of W Murcott

Figure 6. Callus-to-plant regeneration in W. Murcott

Figure 7. In vitro seed germination of Snack mandarin

CITRUS PROTOPLAST ISOLATION, FUSION AND REGENERATION

Figure 8. Procedure of protoplast isolation and fusion. A-D: Protoplast isolation from leaves of Snack E-G: Suspension- derived protoplast isolation of W Murcott, H-I: Leaf and cell suspension protoplasts in sucrose-mannitol mixture, J: Suspension- derived protoplasts, K: Leaf-derived protoplasts, L: Protoplast fusion with PEG (polyethylene glycol), M: Division in fused protoplasts, N-P: Incubation of cultures in growth room under low light conditions.

Out of 2000 embryos recovered from W Murcott + Snack fusion combination; 655 developed shoots, among these 14 plants were confirmed as tetraploids (Fig. 10).

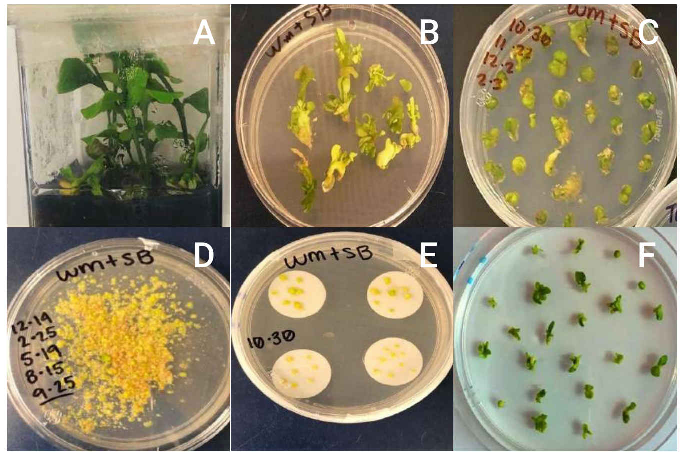

Figure 9. Regeneration via somatic embryogenesis in protoplast fusion combinations of W Murcott + Snake mandarin. A: Callus and embryo formation, B: Small embryo on cellulose filter paper, C-E: Small embryos shifted to culture medium F: Regenerated fusion-derived plants.

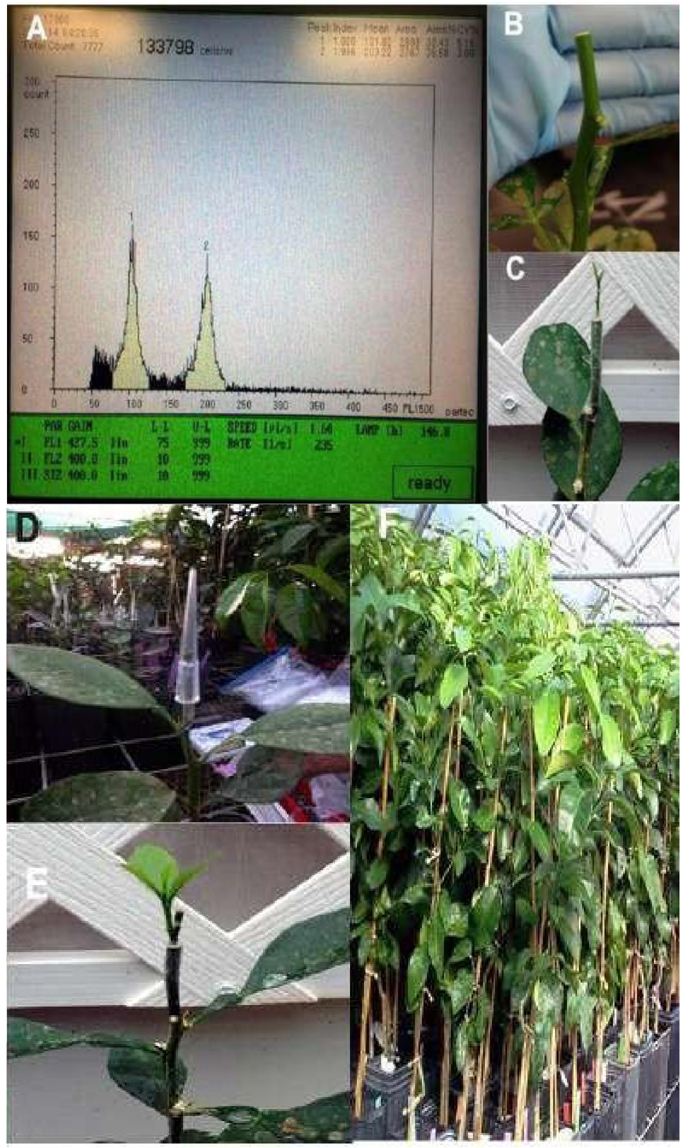

Figure 10. (A-F) Flow cytometric analysis and grafting of W Murcott + Snack hybrids

The shoot tips of recovered tetraploid putative somatic hybrids were micro grafted on commercially available Carrizo citrange (sinensis Osb. x Poncirus trifoliate L. Raf) rootstock (Figure 10). Flow cytometry and EST SSR were used to confirm the ploidy status of these hybrids. Seven EST-SSR primers viz; CX6F06, CX6F07, CX6F09, CX6F010, CX6F14, CX6F17, CX6F19, confirmed all plants as autotetraploid somatic hybrids. All fourteen hybrids had duplicate genomes of their female parent W Murcott and thus were morphologically similar.

Citrus variety W Murcott was used as one of the parents because it is the best regenerative parent and performs well in somatic fusion experiments. Its tetraploids give flowers after 6 years of transplant. Breeding its hybrids with Kinnow can give a seedless crop of intermediate season. It thrives best under arid conditions, so its hybrids can be recommended for arid climatic conditions because it requires less irrigation. The Snack mandarin was used as a leaf parent with W Murcott because it shows tolerance to two serious diseases of citrus known as citrus greening and citrus canker. The confirmed somatic hybrids created in present research will pass from juvenility to reproductive phase. On flowering, the autotetraploid hybrids of W Murcott + Snack will be used as pollen parents in interploid crosses to generate seedless triploids.

Somatic hybridization is more efficient than sexual hybridization as a method for citrus breeding when parents display a complex reproductive biology. It has been successfully used in citrus scion and rootstock breeding programs in the Mediterranean basin, China, Brazil, Japan, Italy, France and Mexico. Thousands of novel somatic hybrids with varying combinations of parents have been generated and exploited as tetraploid breeding parents for designing climate smart scion and rootstock germplasm. Somatic hybridization is a biosafe genetic manipulation tool that has exhibited tremendous potential to address current and future needs of the citrus industry.

THE SUCCESS STORIES OF CITRUS SOMATIC HYBRIDS

1. Production of seedless citrus by triploid somatic hybrids
2. Production of somatic hybrids with consumer choice quality traits like easy peeling skin, sweet taste, good external/internal color, a range of maturity dates, and good shipping ability/shelf-life
3. Creation of novel somatic hybrids with cold-hardiness and disease resistance (citrus canker, citrus tristeza virus, and witches broom), and potential new industrial oils
4. Successful transfer of multigenic traits to desired citrus varieties
5. Broadening the genetic base of citrus germplasm by overcoming obstacles to sexual reproduction and gene transfer of nuclear and cytoplasmic genomes
6. Production of "Tetrazyg" root stock hybrids that possess biotic and abiotic resistances together with wide soil adaptation

EN SUMMARY

Novel somatic hybrids and autotetraploid breeding parents for Citrus scion improvement

Citrus improvement program is based primarily on stacking of suitable traits, which is best achieved via interspecific hybridization of complementary parents. Somatic hybridization and cybridization via protoplast fusion have become an integral part of citrus variety improvement programs worldwide. Two mandarin cultivars, W Murcott (*C. reticulata* Blanco x *C. sinensis* Osbeck) + Snack mandarin (*C. reticulata* Blanco x *C. sinensis* Osbeck) were used in protoplast fusion via PEG- mediated method in different parental combinations. Fifty-six somatic regenerants were obtained. The ploidy evaluation of putative somatic hybrids was carried out through Flow cytometry. The EST-SSR markers were used to evaluate their parental source. Seven EST-SSR primers viz; CX6F06, CX6F07, CX6F09, CX6F010, CX6F14, CX6F17, and CX6F19 confirmed fourteen out of 56 putative somatic hybrids as autotetraploid somatic hybrids. These hybrids exhibited morphology similar to that of W Murcott, with potential to thrive under arid conditions of Pakistan. Their breeding with Kinnow can produce triploid crops of an intermediate season. These hybrids will add new germplasm to the citrus scion breeding program addressing the HLB problem in Pakistan.

FR RÉSUMÉ

Nouveaux hybrides somatiques et parents reproducteurs autotétraploïdes pour l'amélioration des scions d'agrumes

Le programme d'amélioration des agrumes est principalement basé sur l'assemblage de caractères appropriés, ce qui est le mieux réalisé par l'hybridation interspécifique de parents complémentaires. L'hybridation somatique et la cybridation par fusion de protoplastes font désormais partie intégrante des programmes d'amélioration des variétés d'agrumes dans le monde entier. Deux cultivars de mandarine, W Murcott(C. reticulata Blanco x C. sinensis Osbeck) + Snack mandarin(C. reticulata Blanco x C. sinensis Osbeck) ont été utilisés pour la fusion de protoplastes par la méthode PEG dans différentes combinaisons parentales. Cinquante-six régénérants somatiques ont été obtenus. L'évaluation de la ploïdie des hybrides somatiques putatifs a été réalisée à l'aide de la cytomérie de flux. Les marqueurs EST-SSR ont été utilisés pour évaluer leur source parentale. Sept amorces EST-SSR, à savoir CX6F06, CX6F07, CX6F09, CX6F010, CX6F14, CX6F17, CX6F19, ont confirmé que quatorze des 56 hybrides somatiques putatifs étaient des hybrides somatiques autotétraploïdes. Ces hybrides présentaient une morphologie similaire à celle de W Murcott, avec un potentiel de croissance dans les conditions arides du Pakistan. Leur croisement avec le Kinnow peut produire une récolte triploïde d'une saison intermédiaire. Ces hybrides ajouteront un nouveau matériel génétique au programme de sélection des scions d'agrumes pour faire face au problème du HLB au Pakistan.

AR ملخص

أنواع هجينة جسدية جديدة وتربية سلالات ذاتية متعددة الصبغية لتحسين سليل الحمضيات

يعتمد برنامج تحسين الحمضيات بشكل أساسي على تغليف السمات المناسبة التي يتم تحقيقها على أفضل وجه من خلال التهجين بين الأنواع للسلالات التكميلية. حيث أصبح التهجين الجسدي والتكرير عبر اندماج البروتوبلاست جزءًا لا يتجزأ من برامج تحسين أنواع الحمضيات في جميع أنحاء العالم. ولقد تم استخدام صنفين من الماندرين، W Murcott (C. reticulata Blanco x C. sinensis Osbeck) + وجبة خفيفة من الماندرين (C. reticulata Blanco x C. sinensis Osbeck) في اندماج البروتوبلاست عن طريق طريقة PEG- بوساطة مجموعات أبوية مختلفة. وتم الحصول على ستة وخمسين مُجددًا جسديًا. كما تم إجراء تقييم الصيغة الصبغية للهجينة الجسدية المفترضة باستخدام قياس التدفق الخلوي. وتم استخدام علامات EST-SSR لتقييم مصدرها الأبوي. وأكدت سبعة بادئات EST-SSR، وهي؛ CX6F06، CX6F07، CX6F09، CX6F010، CX6F14، CX6F17، CX6F19، أربعة عشر هجينًا جسديًا مفترضًا من أصل 56 هجينًا جسديًا مفترضًا كرباعي الصبغيات. ولقد أظهرت هذه الهجينات شكلاً مورفيًا مثل W Murcott، مع إمكانية الازدهار في ظل الظروف القاحلة في باكستان. ويمكن أن يؤدي تكاثرها مع Kinnow إلى إنتاج محصول ثلاثي الصبغيات لموسم متوسط. وستضيف هذه الأنواع الهجينة مادة وراثية جديدة إلى برنامج تربية سليل الحمضيات الذي يعالج مشكلة HLB في باكستان.

PESTICIDES USE IN KAZAKHSTAN AND POTENTIAL OF BIOTECHNOLOGICAL DEGRADATION INTERVENTIONS

SHUGA MANABAYEVA

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Pesticides are chemicals used to control pests, including insects, weeds, and fungi. Although pesticides increase crop yields and ensure food security by providing effective protection against pests and diseases, they can harm non-target organisms, contaminate soil and water resources, and contribute to the development of resistance to pests and diseases. Therefore, it is important to use pesticides judiciously and adhere to good agricultural practices to minimize their adverse impacts. Certain pesticides, such as organochlorine, mercury-containing, and furan derivatives, are classified as persistent organic pollutants (POPs) and are prohibited to use. Due to their long-lasting presence in the environment, they can lead to long-term ecological consequences[1].

POPs are a group of toxic chemicals that are highly persistent in the environment, resist degradation, and accumulate in the food chain. These substances have severe health effects on humans, animals, and the environment, and their use is regulated under the Stockholm Convention on Persistent Organic Pollutants. The convention aims to protect human health and the environment from the effects of POPs by regulating and, where possible, eliminating their production, use, and trade. Mathew et.al. (2017) classified pollutants based on their nature, use, physical state, pathophysiological effects, and sources. They also examined the effects of pollutants on the environment, including their transformation and accumulation in living organisms through the process of bioaccumulation. Additionally, the study discusses different types of remediation techniques for addressing pollution, such as in situ (on-site) and ex-situ (off-site) remediation methods [2]. Efforts are being made to address pesticide pollution in agriculture. Many countries have established regulations and guidelines to govern pesticide use, including restrictions on certain highly toxic pesticides and maximum residue limits in food. Integrated Pest Management (IPM) practices promote the judicious use of pesticides in combination with other pest control strategies to minimize environmental impacts [3].

In Kazakhstan, soil pollution is caused mainly by pesticides stored in the areas of former storage facilities for plant protection chemicals during the Soviet period. The soils of these sites are heavily contaminated due to the presence of numerous pesticides from different classes and their metabolites. At present, about 1021 trade names of pesticides of various purposes are registered in Kazakhstan. The overwhelming majority of applied pesticides are insecticides, fungicides, and herbicides [4]. The government of Kazakhstan, in collaboration with international organizations such as the Food and Agriculture Organization of the United Nations (FAO), is working to phase out the use of hazardous pesticides and reduce their impacts on human health and the environment. In addition to the stocktaking campaign for obsolete pesticides, the government is promoting the use of integrated pest management (IPM) approaches and encouraging farmers to switch to safer and more sustainable methods of pest control, such as crop rotation, natural predators, and biopesticides.

Kazakhstan never produced POPs. However, in 2003 inventory of POP pesticides identified 727 pesticide stockpiles in Kazakhstan, containing a total of 15 metric tons of toxaphene, 24 metric tons of lindane, and 0.5 metric tons of DDT (commonly known as «dust») [5]. One of the successfully implemented scientific programs in Kazakhstan is funded by the Ministry of Agriculture of the Republic of Kazakhstan, and the Center for Biological Research of the Ministry of Education and Science of the Republic of Kazakhstan. In 2008 a scientific program funded by the International Science and Technology Center (ISTC) «Phytoremediation of Kazakhstan Soils by Pesticides» was completed.

There is a comprehensive legislative framework in place for pesticide management, in Kazakhstan. Specific laws and regulations cover areas such as agriculture, chemical safety, food safety, plant protection, plant quarantine, and protected natural areas. Government agencies, including the Ministry of Agriculture, the Ministry of Ecology, Geology and Natural Resources, and the Ministry of Health, are responsible for pesticide management. Accredited bodies and testing laboratories ensure the conformity and safety of pesticides and monitor residual pesticide quantities in products. Kazakhstan is actively involved in international agreements and has ratified the Stockholm Convention, the Rotterdam Convention, and the Montreal Protocol, which address the regulation and control of hazardous pesticides.

One of the sources of environmental pollution in the reservoir of the East region of Kazakhstan was the Ust-Kamenogorsk capacitor plant. The plant used trichlorobiphenyl (TCBP) as an impregnating dielectric fluid during the production of capacitors. The TCBP contained up to 2.5% highly chlorinated biphenyls (HCBs), such as chlorophen A-5 and A-60. These biphenyls belong to the group of organochlorine pesticides (OCPs) and are highly toxic and persistent environmentally and biologically. This created a problem of soil and water pollution and potential impact on living organisms, including plants, animals, and people residing in the area [6].

Pesticide residues in grain and the associated health risks were investigated by Lozowicka et al [7]. A total of 80 samples: barley, oat, rye, and wheat were collected and tested in the accredited laboratory. Among 180 pesticides, 10 active substances were detected. The study revealed that aldrin in wheat had the highest estimated daily intake (789% of the Acceptable Daily Intake) and posed an acute risk (315.9% of the Acute Reference Dose). Pirimiphos methyl in wheat and rye also had a significant EDI (49.8% of the ADI) and tebuconazole in wheat presented an acute risk (98.7% of the ARfD). These findings highlight the potential health concerns associated with pesticide exposure and emphasize the need for continued monitoring and research in this area.

In 2022, a project was launched in Kazakhstan to phase out pesticides classified as POPs through a stocktaking campaign. The project is being implemented by the Food and Agriculture Organization of the United Nations (FAO), in collaboration with the Ministry of Ecology, Geology and Natural Resources, and local executive authorities.

One of the best solutions for cleaning contaminated land is phytoremediation. Phytoremediation is a technology for the restoration of a polluted environment using various plant species by saving soil fertility [8, 9]. Phytoremediation technology is used directly in the area of pollution (in situ), contributing to reducing costs and reducing the contact of contaminated xenobiotics with people and the environment. One of the key moments of phytoremediation is the optimal composition of tolerant species of plants that are not only able to survive in the pollution but to transform and neutralize them. This technology is environmentally safe and economically viable. The choice of plants for this technology is determined by their ability to carry soil water to the surface through evapotranspiration, to split polluting compounds using enzymes, and to store these compounds in biomass [10]. Based on the ability of plants to render harmless anthropogenic toxicants, phytoremediation over the past decade has evolved from a conceptual, methodological approach to an environmentally important, competitive commercial technology for cleaning the environment from organic and inorganic toxic compounds. The effectiveness of phytoremediation processes is largely determined by the ability of the plant itself to absorb and accumulate in cellular structures inorganic and organic toxicants and carry out a deep oxidative degradation of organic xenobiotics. For more than two decades, the possibility of using plants for cleaning soils, groundwater, and water bodies from inorganic toxicants has been widely discussed. Judging by the results achieved, it is certain that phytoextraction in situ conditions is the cheapest technology that does not affect soil structure, which increasingly attracts the attention of scientists and agrarian practitioners, as well as ecologists [11].

Research on phytoremediation for soils contaminated with organochlorine pesticides in the area of the former warehouse of obsolete pesticides, located in the village of Kyzylkairat, Talgar district, Almaty region of Kazakhstan, is being carried out by local scientists [12]. The study found that the addition of soil additives improved the growth parameters of M. sinensis, while the use of Tween 20 increased the uptake and transmigration of certain OCPs to the aboveground biomass. Conversely, the addition of activated carbon reduced OCP uptake by plants/ Overall, modifying OCP-contaminated soil with Tween 20 accelerated the recovery process, and the inclusion of activated charcoal facilitated the production of relatively pure biomass for energy purposes. The study also examined the pesticide content in animal products such as meat, milk, and honey. A correlation was established between the pesticide levels in food and the occurrence of chromosomal aberrations in the population of the studied villages.[13]. Furthermore, the researchers analyzed the total pesticide content in the soil at the study sites and observed a correlation with the frequency of mutations in Drosophila. They also demonstrated the presence of chromosomal aberrations in lymphocyte cultures of sheep and cattle [14].

Five special types of phytoremediation have been defined for removing POPs from the environment: (i) Phytodegradation, degrading organic pollutants in the soil or within the plant tissue through specific enzymes that the plant roots secrete; (ii) Phytovolatilization, taking up pollutants from the soil or water and releasing them into the atmosphere through plant transpiration; (iii) Phytostabilization, focusing mainly on soil pollutants near the roots, resulting in a reduction of soil erosion; (iv) Phytoextraction, using the ability of plants or algae to remove contaminants from soil or water and concentrating them above ground in the plant biomass; (v) Phytostimulation by using organisms within the rhizosphere to remove dangerous organic contaminants from soil [15].

The genetic engineering of plants is one of the advances in the field of phytoremediation, overcoming many of the obstacles of traditional phytoremediation and genetic engineering techniques have shown promising results in enhancing the efficiency of phytoremediation by manipulating the genes responsible for metal uptake, transport, sequestration, and the degradation of hazardous organic compounds [16-18]. The primary reason for the need to use transgenic plants for phytoremediation is that the plants lack the necessary enzymatic machinery for the effective degradation of pollutants, unlike bacteria or mammals. For example, rice plants have been successfully transformed with genes encoding cytochrome P450 monooxygenases (CYP1A1, CYP2B6, and CYP2C19). The resulting transgenic rice plants exhibited increased tolerance to various herbicides compared to non-transgenic plants, due to the enhanced metabolism facilitated by the introduced P450 enzymes [19]. The complex naphthalene dioxygenase system, responsible for the degradation of polycyclic aromatic hydrocarbons (PAHs) in bacteria, was successfully transferred into Arabidopsis and rice plants. For the first time, all four genes of the naphthalene dioxygenase system were simultaneously expressed and assembled to form an active enzyme in transgenic plants. The introduction of this system into plants conferred the ability to tolerate high concentrations of phenanthrene, a specific PAH, and metabolize it in vivo [20]. Arabidopsis thaliana plants genetically modified with the P450 CYP1A2 gene were used to metabolize various herbicides, insecticides, and industrial chemicals. The specific focus was on the herbicide simazine (SIM). The results revealed that transgenic A. thaliana plants expressing the CYP1A2 gene exhibited significant resistance to SIM, whether it was supplemented in the growth medium or sprayed on the plant's foliage [21]. Transgenic poplar plants overexpressing a cytosolic glutamine synthetase (GS1) were developed to assimilate and utilize high levels of nitrate. The transgenic plants exhibited increased biomass and accumulated higher levels of proteins, chlorophylls, and total sugars compared to the wild-type controls when grown under high nitrate levels, indicating enhanced growth and productivity [22]. In 2022, Tussipkan and Manabayeva conducted a review that emphasizes the utilization of transgenic alfalfa (Medicago sativa L.) plants to improve the process of phytoremediation for persistent organic pollutants (POPs) such as atrazine, polychlorinated biphenyls (PCBs), trichloroethylene (TCE), petroleum, and heavy metals. This highlights the potential of genetically modified alfalfa to effectively remove these contaminants from the environment. The review also discusses future prospects and possibilities for enhancing the efficiency of phytoremediation, paving the way for further advancements in this field [23].

Phytoremediation processes by transgenic plants include phytoaccumulation (plants take up persistent organic and inorganic pollutants with soil water and store the contaminants in their tissues) and phytodegradation (metabolism of contaminants within plants due to the expression of transgenes). The phytotoxic effects of atrazine, polychlorinated biphenyl (PCB), and petroleum are overcome by expressing the bacterial genes AtzA, bphC, B, and rhlA. Expression of mammalian genes CYP2E1 and GST enhances the degradation of trichloroethylene (TCE). Overexpression of plant gene ATPS improves heavy metal tolerance. The Degradation of pollutants into non-toxic metabolites occurs by the enzymes transcribed by the inserted genes (Figure 1).

It has been reported that microbe-mediated phytoremediation is a promising approach for treating mixed pollutants [24]. Bacteria and fungi have been found to promote plant growth, alleviate stress, and degrade pollutants. These beneficial microbes enable plants to thrive in soil with high pollutant concentrations by producing growth-promoting substances. They mobilize pollutants in the rhizosphere, allowing plants to absorb them. In a study, 580 strains of microbes were isolated from the rhizosphere of Cucurbita pepo L. and Xanthium strumarium plants, grown in soil contaminated with DDT and its metabolites in the territory of the former warehouse of obsolete pesticides in the Almaty region. Two bacterial strains, Bacillus vallismortis and Bacillus aryabhattai, were identified for their ability to utilize DDE as a carbon source. These strains showed a high capacity to consume DDE, with over 90% of the pollutant being utilized within 21 days. Laboratory experiments demonstrated that inoculating C. pepo and X. strumarium with these strains reduced pollutant stress, resulting in increased aboveground and root biomass. The microbes enhanced the plants' ability to absorb and stabilize pollutants, suggesting their potential for phytoremediation of soils contaminated with DDE [25].

In summary, phytoremediation, utilizing plants and microorganisms, provides a promising solution for restoring pesticide-contaminated soils and addressing urgent environmental concerns. The integration of genetically engineered plants and microorganisms found in the rhizosphere of plants growing in contaminated soil is crucial for advancing phytoremediation technology. This approach enhances the efficiency of remediating soils contaminated with persistent organic pesticides. Implementing these strategies holds the potential for restoring and rehabilitating polluted environments, contributing to a more sustainable and ecologically balanced ecosystem.

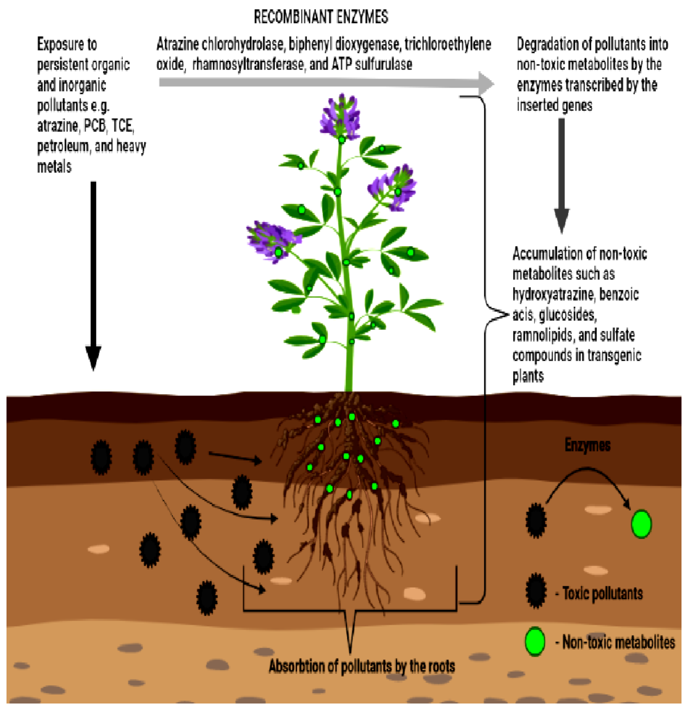

Figure 1. Schematic representation of phytoremediation strategies by transgenic alfalfa plants.

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EN SUMMARY

Pesticides use in Kazakhstan and potential of biotechnological degradation interventions

Soil contamination resulting from industrial and agricultural activities poses significant risks to both human health and the environment. Persistent organic pollutants (POPs) are of particular concern due to their long-lasting nature and resistance to degradation. However, some plant species have a high capacity to grow and survive in elevated levels of contaminants, offering potential for biotechnological interventions. This review provides a comprehensive overview of pesticide usage in Kazakhstan and explores the possibilities of utilizing biotechnological approaches for degradation. The potential of both non-transgenic and transgenic plants for phytoremediation, as well as the efficacy of bioremediation methods, are discussed. This information serves as a foundation for future research aimed at enhancing the efficiency of phytoremediation techniques.

FR RÉSUMÉ

Utilisation des pesticides au Kazakhstan et potentiel des interventions de dégradation biotechnologique

La contamination des sols résultant des activités industrielles et agricoles pose des risques importants tant pour la santé humaine que pour l'environnement. Les polluants organiques persistants (POP) sont particulièrement préoccupants en raison de leur nature durable et de leur résistance à la dégradation. Cependant, certaines espèces végétales ont une grande capacité à croître et à survivre dans des niveaux élevés de contaminants, offrant un potentiel pour des interventions biotechnologiques. Cette revue fournit un aperçu complet de l'utilisation des pesticides au Kazakhstan et explore les possibilités d'utiliser des approches biotechnologiques pour la dégradation. Le potentiel des plantes non transgéniques et transgéniques pour la phytoremédiation, ainsi que l'efficacité des méthodes de bioremédiation, sont discutés. Ces informations servent de base à de futures recherches visant à améliorer l'efficacité des techniques de phytoremédiation.

AR ملخص

استخدام مبيدات الآفات في كازاخستان وإمكانية تدخلات التكنولوجيا الحيوية

يشكل تلوث التربة الناتج عن الأنشطة الصناعية والزراعية مخاطر كبيرة على كل من صحة الإنسان والبيئة. تعتبر الملوثات العضوية الثابتة (POPs) مصدر قلق خاص بسبب طبيعتها طويلة الأمد ومقاومتها. ومع ذلك ، فإن بعض أنواع النباتات لديها قدرة عالية على النمو والبقاء على قيد الحياة في مستويات مرتفعة من الملوثات ، مما يوفر إمكانية التدخلات الحيوية. تقدم هذه المراجعة نظرة عامة شاملة عن استخدام مبيدات الآفات في كازاخستان وتستكشف إمكانيات استخدام مناهج التكنولوجيا الحيوية للتحلل. وتناقش آفاق كل من النباتات غير المعدلة وراثيا والمعالجة النباتية ، فضلا عن فعالية طرق المعالجة الحيوية. تعمل هذه المعلومات كأساس للبحث المستقبلي الذي يهدف إلى تعزيز كفاءة تقنيات المعالجة بالنباتات.

VIGS-MEDIATED FUNCTIONAL GENOMICS: FINDING NEW GENES FOR DEVELOPING CLIMATE RESILIENT CROPS

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VIRUS INDUCED GENE SILENCING OF SPY GENE RELATED TO DROUGHT STRESS IN COTTON

Virus-induced gene silencing (VIGS) is a powerful technique used in plant research to study gene function. It involves the use of viral vectors to specifically target and silence the expression of a target gene in plants (Shi et al., 2022). VIGS allows researchers to investigate the effects of gene silencing on plant development, physiology, and response to various stresses. Tobacco rattle virus-based (TRV-based) VIGS has been employed effectively to change gene expression in Nicotiana spp., Arabidopsis thaliana, G. arboreum, Petunia hybrida, Solanum lycopersicum, and other effective and essential plant species (Li et al., 2022).

Because TRV has many benefits over other virus infections made for VIGS, such as mild infection signs, the ability to infect large patches of nearby cells, migration to growing meristematic cells, and easily spread to fresh plant tissues, it is currently the most efficient method (Manchur et al., 2022).

SPY gene, used in this study, is a member of the protein superfamily that regulates drought stress negatively. In silico study was done to evaluate the structure and function of the spy gene. The complete coding sequence of the gene was retrieved from Cotton FGD (Samantara et al., 2022). For understanding the patterns in the gene structure and motifs in the protein which are important for protein-protein interaction, domain analysis of the protein was done using the Pfam tool.

The mRNA sequence was retrieved to select the specific target site. The protein sequence was used to find the protein domain to specify the target. The structural analysis of the SPY gene was done through gene structure display server 2.0. It is vital to understand the mRNA sequence to comprehend the structure of the gene (Biswas et al., 2021). The vector is designed using the Snap Gene V. 6.1. Vector was 16437 bp in size having a 2.7 kb SPY gene. SPY gene was controlled by a 35S terminator and promoter. Kanamycin was used as a selection marker (Anu et al., 2021). The binary vector contains left (LB) and right borders (RB). SPY gene was designed in the T-DNA region. Briefly, the target gene sequence is retrieved and cloned in the VIGS vector. The Agrobacterium was then prepared for agro-infiltration. The vector was then mobilized into Agrobacterium (Fig:1).

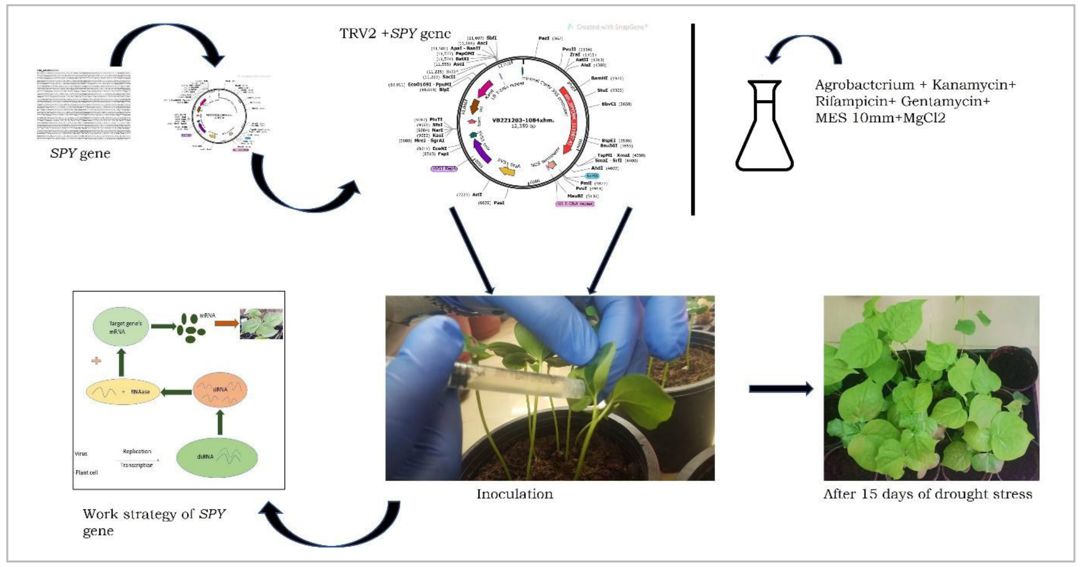

Figure 1. VIGS workflow in Plants. Briefly, target gene sequence is retrieved and cloned in the VIGS vector. The vector is then mobilized into Agrobacterium. The Agrobacterium is then prepared for agro-infiltration. After agro-infiltration, the gene silencing is evaluated.

After the TRV2 vector inoculation with the SPY gene in cotton to produce drought stress tolerance, the efficiency of gene silencing was evaluated by measuring the levels of expression of endogenous genes using reverse transcription polymerase chain reaction (RT-PCR) with RNA taken from control and silenced cotton plants. This was done to determine whether gene silencing was successful (Yue et al., 2022). After the VIGS treatment, the effects of gene silencing were also evaluated by assessing changes in the phenotype or gene expression of the silenced plants. This involves measuring plant growth, development, or response to specific stresses, as well as quantifying the expression levels of the target gene and related genes (Cunha et al., 2019). Various reporter-based VIGS methods that may operate as either negative or positive regulators are additionally created. Because VIGS is fast, it only has a temporary mutation impact. It leads to a quick suppression of the target gene, which can be utilized to evaluate RNA-suppressing sequences prior to persistent transformation, although, in certain circumstances, more laborious approaches can clearly demonstrate a gene's function (Jain et al., 2010). VIGS has proven to be a valuable tool in functional genomics and plant research. It provides a rapid and efficient means to investigate gene function and decipher complex gene networks. By silencing particular genes in plant biology, researchers may learn more about their activities and get a better knowledge of many physiological processes (Bhattacharjee et al., 2022). VIGS is very useful for analyzing critical genes that would be difficult to examine using other genetic alteration procedures.

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EN SUMMARY

VIGS-mediated Functional Genomics: Finding New Genes for Developing Climate Resilient Crops

Climate change adversely impacts agricultural production and food security. Frequent and intense weather conditions such as floods, droughts, heat waves, and storms cause crop damage, decrease yields, and even crop failure due to abiotic and biotic stresses. Drought is a significant abiotic stress that inhibits plant growth and development by altering metabolic pathways. The effects of climate change on global food security include low crop production and decreased crop yields. Identifying and introducing new genes that confer tolerance to abiotic stress factors such as drought, extreme temperatures, and soil salinity is one of the strategies for developing climate resilient crops. Therefore, mining genes from stress response pathways for abiotic stress tolerance is a way forward to develop climate resilient cultivars. This typically involves identifying genes in model plant species using molecular biology techniques. Once these genes have been identified, genetic engineering techniques can be used to introduce them into different plants. Virus induced gene silencing (VIGS), a rapid and effective transient technique to evaluate gene function, was developed to assist high throughput functional genomics on large-scale. Spindly (SPY) gene is a negative regulator of drought stress in cotton. The current study was designed to silence SPY gene through VIGS using binary vector pYL156 (TRV RNA2) in cotton. The SPY homolog in cotton was designed, cloned, and put into the vector. The agroinfiltration method was used to introduce VIGS vectors in plant leaves. Drought stress was applied to trigger the expression of stress-responsive genes. The gene expression was quantified through qPCR in both stressed and normal plants. Low gene expression was observed from 7-14 days post infiltration (dpi). Thus, food security can be ensured by promoting sustainable agriculture techniques, promoting crop diversification, bolstering safety nets, and confronting climate change.

FR RÉSUMÉ

Génomique fonctionnelle médiée par VIGS : Trouver de nouveaux gènes pour développer des cultures résistantes au climat

Le changement climatique a un impact considérable sur la production agricole et la sécurité alimentaire. Le changement climatique entraîne une augmentation de la fréquence et de l'intensité des phénomènes météorologiques tels que les inondations, les sécheresses, les vagues de chaleur et les tempêtes. Ces événements peuvent causer des dommages aux cultures, une diminution des rendements, voire une perte de récolte. Les stress abiotiques et biotiques sont deux facteurs principaux qui peuvent avoir un impact considérable sur la production agricole, entraînant des pertes de récoltes significatives en endommageant les plantes et en diminuant le rendement. Pour trouver de nouveaux gènes de tolérance au stress abiotique, il faut généralement identifier les gènes impliqués dans les voies de réponse au stress chez les espèces végétales modèles à l'aide de techniques de biologie moléculaire. L'extinction des gènes induite par les virus est une technique transitoire rapide et efficace pour évaluer la fonction des gènes. Elle a été mise au point pour faciliter les études de génomique fonctionnelle à haut débit dans différentes cultures. Le VIGS est une approche puissante pour les études d'expression génique rapides et à grande échelle dans les études de génomique fonctionnelle. En promouvant des techniques agricoles durables, en encourageant la diversification des cultures, en renforçant les filets de sécurité et en luttant contre le changement climatique, nous pouvons faire en sorte que chacun ait accès à une alimentation suffisante et à une meilleure nutrition.

AR ملخص

علم الجينوم الوظيفي الذي يستخدم تقنية إسكات الجينات الناجم عن الفيروسات (VIGS) كواسطة: إيجاد جينات جديدة لتطوير محاصيل مقاومة للمناخ

يأثر تغير المناخ بشكل كبير على الإنتاج الزراعي والأمن الغذائي. وتترتب عن تغير المناخ ظروف جوية أكثر تكرارًا وشدة مثل الفيضانات والجفاف وموجات الحرارة والعواصف. ويمكن أن تتسبب هذه الأحداث في تلف المحاصيل وانخفاض الغلات وحتى فشل المحاصيل. وتعتبر الضغوط اللاأحيائية والحيوية عاملين رئيسيين يمكن أن يؤثرا بشكل كبير على إنتاج المحاصيل، مما يتسبب في خسائر كبيرة في المحاصيل عن طريق إتلاف النباتات وتقليل المحصول. وعادةً ما ينطوي إيجاد جينات جديدة لتحمل الإجهاد اللاأحيائي على تحديد الجينات المتواجدة في مسارات الاستجابة للإجهاد في أنواع النباتات النموذجية بأستخدام تقنيات البيولوجيا الجزيئية. ويُعتبر إسكات الجينات الناجم عن الفيروسات أحد التقنيات العابرة السريعة والفعالة لتقييم وظيفة الجينات للمساعدة في دراسات الجينوم الوظيفي عالية الإنتاجية في المحاصيل المختلفة. ويُعد إسكات الجينات الناجم عن الفيروسات نهجًا قويًا لدراسات التعبير الجيني السريعة واسعة النطاق في الدراسات الجينومية الوظيفية. ويمكننا ضمان حصول الجميع على الغذاء الكافي مع التغذية المحسنة من خلال تعزيز تقنيات الزراعة المستدامة، وتعزيز تنويع المحاصيل، وتعزيز شبكات الأمان، ومواجهة تغير المناخ.

GAPS IN HUMANITARIAN ASSISTANCE IN AFGHANISTAN AND IOFS FOOD CRISIS RESPONSE THROUGH AFGHANISTAN FOOD SECURITY PROGRAM (AFSP)

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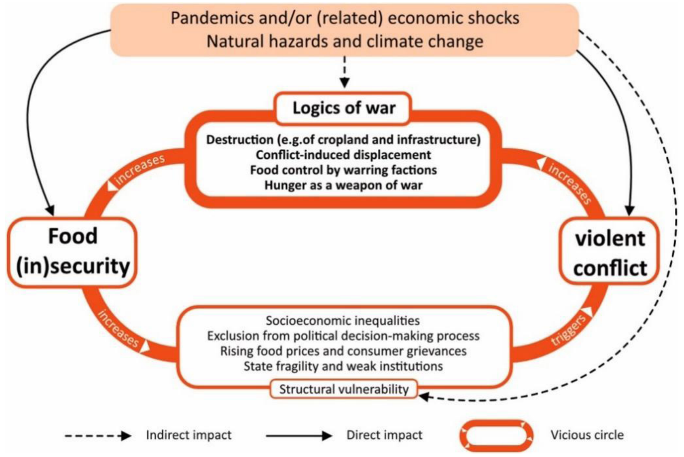
According to a recent UN OCHA situation report[1] by 2022, Afghanistan's population is projected to surpass 43 million, with 47% of its inhabitants under the age of 15 being one of the largest youth populations globally. The population is predicted to grow at a rapid rate of 2.3% annually as the country faces complex emergencies and crises related to the environment, economy, and protection. In 2023, 28.3 million individuals, equivalent to two-thirds of Afghanistan's population, require immediate humanitarian aid to ensure their survival. This pressing need arises as Afghanistan enters its third consecutive year of drought-like conditions and its second year of severe economic decline. Moreover, the country is still grappling with the aftermath of four decades of conflict and recurrent natural disasters. Widespread unemployment and persistently high prices for essential goods have resulted in increased household debts, placing significant strain on people's ability to cope and exacerbating the already fragile economy's resilience against unforeseen shocks. The visible consequences of conflicts on food security primarily involve the devastation of agricultural land, irrigation systems, and infrastructure. Consequently, chronic food insecurity becomes a critical factor in perpetuating or escalating the crisis, initiating a destructive cycle of violence and hunger.

Another study[2] highlights that approximately 17 million people are confronting severe hunger in 2023. Among them, 6 million individuals are experiencing emergency levels of food insecurity, on the brink of famine—an alarmingly high record globally. The situation has deteriorated further in the first quarter of 2023 due to the climatic conditions and lean season, sustained high food prices, reduced income, and escalating unemployment. Anticipated deficiencies in agricultural yields and reduced harvests during the year 2022 will impact the state of food security in 2023. The wheat deficit experienced at the national level amounted to approximately 4 million metric tons in 2022, representing 40% of the total wheat demand to meet the population's needs. This disparity in supply and demand has far-reaching projections based on anticipated La Niña weather phenomena. In parallel, livestock keepers are confronted with ongoing and persistent outbreaks of diseases. In turn, escalating food prices, widening social disparities, exclusion from political decision-making processes, and the fragility of states act as potential catalysts for armed conflicts as it is figured by scholars below.



Source: Kemmerling, B., Schetter, C., & Wirkus, L. (2022). The logics of war and food (in) security. Global Food Security, 33, p.3.

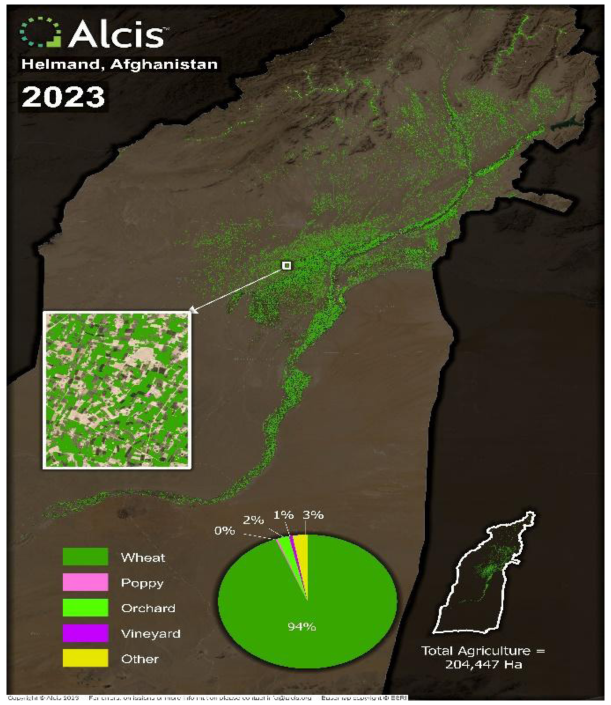
To understand and address this detrimental cycle we need to look at new analytical frameworks. Since the World Humanitarian Summit in 2016, the humanitarian, development, and peace nexus (HDP-nexus) debate has emerged as a significant concern due to the distinct mandates of humanitarian assistance, development, and peacebuilding that work in silos. The 'triple nexus' approach[3] aims to combine the expertise of professionals in the fields of humanitarian aid, development, and peacebuilding. The goal is to overcome challenges through both programmatic and structural changes within the aid system itself. While the theory behind this approach seems straightforward, its implementation and operationalization needs harmonisation of humanitarian and development efforts in planning, financing, and coordination. In the context of the complex and prolonged situation in Afghanistan, a crucial strategy for achieving Sustainable Development Goal 2, specifically target 1, is ending hunger and ensuring access to food and nutrition for vulnerable populations during and immediately after emergencies.

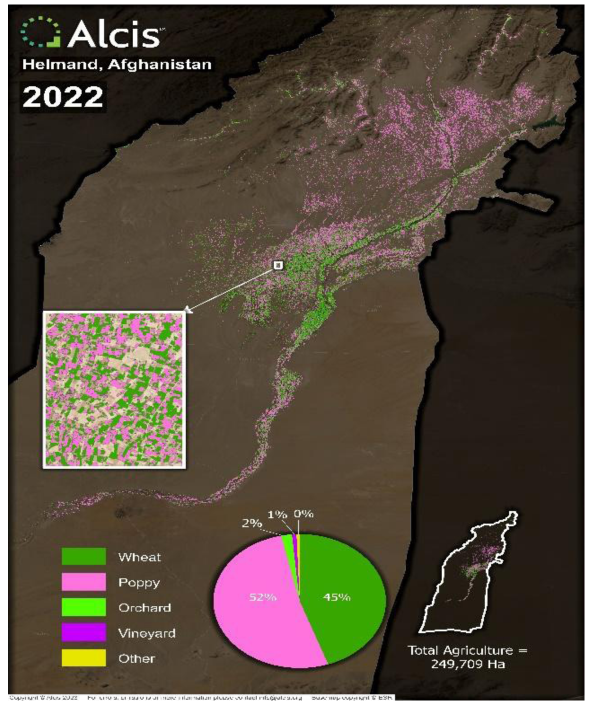
Regarding Afghanistan to operationalise from that lens, if peace and stability continues, activities beyond humanitarian will be scaled up, such as mid-and long-term development projects

1 Afghanistan Humanitarian Needs Overview January 2023, OCHA, accesses at https://reliefweb.int/report/afghanistan/afghanistan-humanitarian-needs-overview-2023-january-2023
2 Food Cluster Report March 2023 , accesses at https://fscluster.org/afghanistan/document/guideline-food-security-and-agriculture
3 Howe, P. (2019). The triple nexus: A potential approach to supporting the achievement of the Sustainable Development Goals?. World Development, 124, 104629.

such as enhancing value chains that can improve rural livelihoods through market integration, basic food processing in urban areas and limited export markets particularly. To establish this engagement between humanitarian endeavours, development initiatives, and efforts in peacebuilding, the provision of food plays a pivotal role in the initial stage. During periods of food crises, short-term food aid efforts concentrate on enhancing the dietary intake of affected individuals and communities.

On the other hand, amidst this grim statistics and overview provided, some positive changes are also visible on the ground, shared by various international media outlets.4 Substantial reduction in the cultivation of opium poppies this year in Afghanistan signals the efforts of local and international actors. The research group Alcis, utilizing high-resolution satellite imagery and other research methods, has revealed that nationwide poppy production has dropped by 99% in Helmand province. It shows that land previously utilized for poppy cultivation has been repurposed for growing wheat, highlighting a shift in agricultural practices.





Source : https://www.alcis.org/poppy

In this regard, it is crucial for global stakeholders to motivate farmers by minimizing uncertainty through establishing alternative livelihoods by 'crop substitution' replacing poppy farming. The 'Policymakers and professionals must acknowledge the significance of diversity in their endeavours to complement security measures, thereby enhancing their effectiveness through supporting the cultivation of wheat and other crops locally to bridge the gap.

Obviously, to address these issues as an emerging actor, Islamic Organization for Food Security (IOFS) plays a significant role in addressing humanitarian crises in Afghanistan. In response to the complex and severe nature of protracted crises, the IOFS has designed and implemented multiple action plans within the Organization of Islamic Cooperation (OIC) geography and beyond. For instance, IOFS launched the Afghanistan Food Security Programme (AFSP), which was identified as a key outcome of the 17th Extraordinary Council of Foreign Ministers on the Humanitarian Situation in Afghanistan. The IOFS is mandated with implementing the program using its funds and other resources. The resolution also encouraged OIC member countries, international donors, UN funds and programs, and other international actors to contribute to the AFSP. Under the AFSP initiative, the IOFS has developed four projects, including the supply of wheat flour to Afghanistan in partnership with Kazakhstan and Tajikistan under 'Flour for Humanity'; emergency food support through a partnership with the ICIC (Islamic Committee of the International Crescent); a model case for cereals cultivation and flour production; and potable water cleaning facilities for rural areas which will be scaled up in upcoming days. As part of stabilization efforts, recent IOFS support to Drug Treatment Centres (DTCs) of UNODC with wheat flour under UNAMA coordination is considered another milestone for supporting the noble initiative of fight against drugs. The planned livelihood projects on cereal production and basic food processing will create employment and increase the local food production in Afghanistan. In this case, the multifaceted interventions of IOFS will complement the pillars of nexus approach.

In tandem with the political will and the solidarity spirit within OIC member countries, IOFS aims to leverage its humanitarian footprint to contribute beyond humanitarian objectives. As continuing to provide wheat flour the sustainable projects that will create value on the food systems in Afghanistan will contribute to the nexus logic in the future. IOFS is committed to work to ensure that all of its humanitarian programming is conflict sensitive, contextually grounded, and adopts a 'Do No Harm' approach future of response strategies for efficiency and effectiveness within OIC and other institutions and to prevent duplications and fragmentation in its provision.

4 BBC and Sputnik Briefs, accessed at https://sputnikglobe.com/20230610/the-talibans-ban-works-opium-production-collapses-in-afghanistan-1111020122.html https://www.bbc.com/news/world-asia-65787391

EN SUMMARY

Gaps in Humanitarian Assistance in Afghanistan and IOFS Food Crisis Response through Afghanistan Food Security Program (AFSP)

Afghanistan, a country ravaged by decades of conflict and instability, faces many challenges to ensure food security for its population. The humanitarian aspect of Afghanistan's food security crisis is a pressing concern, requiring immediate attention from national and international stakeholders.

This article aims to provide a background analysis of the humanitarian situation in Afghanistan. It explores how the Islamic Organization for Food Security (IOFS) views humanitarian assistance through the lens of food security, with a focus on long-term stability and the importance of building food secure communities in Afghanistan. It emphasizes the need to prioritize human dignity by ensuring access, affordability to adequate food for sustainable food systems.

FR RÉSUMÉ

Les insuffisances de l'assistance humanitaire en Afghanistan et la réponse de l'Organisation Islamique pour la Sécurité Alimentaire (IOFS) à la crise alimentaire grâce au Programme de Sécurité Alimentaire en Afghanistan (AFSP)

L'Afghanistan, un pays ravagé par des décennies de conflits et d'instabilité, fait face à de nombreux défis pour assurer la sécurité alimentaire de sa population. L'aspect humanitaire de la crise de sécurité alimentaire en Afghanistan est une préoccupation urgente qui nécessite une attention immédiate de la part des acteurs nationaux et internationaux.

Cet article vise à fournir une analyse contextuelle de la situation humanitaire en Afghanistan. Il explore la façon dont l'Organisation Islamique pour la Sécurité Alimentaire (IOFS) perçoit l'assistance humanitaire à travers le prisme de la sécurité alimentaire, en mettant l'accent sur la stabilité à long terme et l'importance de construire des communautés alimentaires sûres en Afghanistan. Il souligne la nécessité de donner la priorité à la dignité humaine en assurant l'accès et l'abordabilité à une alimentation adéquate pour des systèmes alimentaires durables.

AR ملخص

الثغرات في المساعدة الإنسانية في أفغانستان واستجابة المنظمة الاسلامية للأمن الغذائي لأزمة الغذاء من خلال برنامج الأمن الغذائي في أفغانستان (AFSP)

تواجه أفغانستان، البلد الذي دمرته عقود من الصراع وعدم الاستقرار، العديد من التحديات لضمان الأمن الغذائي لسكانها. يمثل الجانب الإنساني لأزمة الأمن الغذائي في أفغانستان مصدر قلق ملح، ويتطلب اهتمامًا فوريًا من أصحاب المصلحة الوطنيين والدوليين.

فكرة عامة

تهدف هذه المقالة إلى تقديم تحليل أساسي للوضع الإنساني في أفغانستان. وتستكشف كيف تنظر المنظمة الإسلامية للأمن الغذائي (IOFS) إلى المساعدة الإنسانية من منظور الأمن الغذائي، مع التركيز على الاستقرار على المدى الطويل وأهمية بناء مجتمعات تتمتع بالأمن الغذائي في أفغانستان. وتؤكد على الحاجة إلى إعطاء الأولوية لكرامة الإنسان من خلال ضمان الوصول إلى الغذاء الكافي والقدرة على تحمل تكلفته من أجل النظم الغذائية المستدامة.

IOFS NEWS OVER MID-MARCH-APRIL-MAY-JUNE (TILL 08.06.2023)

IOFS participates in the 24th Conference of the Islamic World Academy of Sciences

IOFS Director Programs and Project Department Prof. Dr. Zulfiqar Ali participated in the 24th Conference of the Islamic World Academy of Sciences (IAS) on "Challenges to Promote Science & Technology for Socio-Economic Development in OIC Countries" held in Karachi, Pakistan, during March 7 – 8, 2023 in collaboration with COMSTECH - OIC Standing Committee on Scientific and Technological Cooperation. During the two-day major event, gaps are being identified for the promotion of science, technology and innovation to address the contemporary challenges of development, poverty eradication, environment, education for all, climate change, human health, and energy and water resources.

Strengthening cooperation between the IOFS and the Islamic Republic of Mauritania

During a meeting in September 2022 in Cairo, Egypt, the Director General of IOFS Prof. Yerlan Alimzhanuly Baidaulet and the Commissioner for Food Security (CSA), of the Islamic Republic of Mauritania, H.E. Ms. Fatimetou Mint Khatry, discussed prospects for cooperation between IOFS and the Islamic Republic of Mauritania on improving the current state of the strategic commodities reserve in the country. To continue the deliberations of strategic collaboration between IOFS and CSA, Dr. Ismail AbdelHamid, Advisor, Program and Project Department, is visiting Nouakchott.

IOFS Meeting with the Ambassador of the Kingdom of Saudi Arabia to the Republic of Kazakhstan

On March 10, 2023, H.E. Prof. Yerlan A. Baidaulet, Director-General of IOFS, paid a courtesy visit to the Saudi Embassy and met with H.E. Mr. Faisal H. Alkahtani, the newly appointed KSA Ambassador to the Republic of Kazakhstan.

H.E. Prof. Baidaulet started the meeting by congratulating H.E. Alkahtani on his appointment as the new KSA Ambassador in Astana and wishing him success in his new duties. He also expressed the hope that this new development would serve as a catalyst for further improving the excellent bilateral ties between Kazakhstan and the KSA as well as with the IOFS.

IOFS participates in INWRDAM 13TH International Symposium

The delegation of the Islamic Organization for Food Security, headed by the Director General, H.E. Prof. Yerlan Baidaulet, participates in the Inter-Islamic Network on Water Resources Development and Management (INWRDAM) 13th International Symposium organized in Amman, the Hashemite Kingdom of Jordan, under the patronage and with the great speech of HRH Prince Hassan Bin Talal.

IOFS Welcomes Visitors at the 19th Edition of DIHAD

The delegation of the IOFS arrived to Dubai, UAE on the 13th of March to participate in the 19th Edition of DIHAD Conference and Exhibition 2023, held under the patronage of H.H. Sheikh Mohammed Bin Rashid Al Maktoum, Vice-President and Prime Minister of the UAE and Ruler of Dubai.

The Director General of IOFS H.E. Prof. Yerlan Baidaulet launched the second day of DIHAD with a keynote statement on the Sustainability of the IOFS Afghanistan Food Security Program. Prof. Baidaulet began by reporting on the activities of the IOFS in ensuring food security to Member States, including through the development of knowledge, the exchange of various technological solutions and sustainable agricultural practices.

IOFS AND IFPA WELCOME AGRITEQ PARTICIPANTS

On March 15, Qatar's International Agricultural Exhibition (AgriteQ) launched in Doha, with the aim of accelerating the means to achieving the goals of Qatar National Food Strategy. This year, AgriteQ is celebrating its 10th edition from 15-19 March at the Doha Exhibition and Convention Center (DECC). The Islamic Organization for Food Security and International Islamic Food Processing Association (IFPA) were invited to attend the august exhibition by the Ministry of Municipality.

IOFS Organized Wheat Task Force's visit to Mauritania to kick-start implementation of Regional Project on country's Wheat System Improvement

On 17 March 2023, the Director General of IOFS wraps up the Inception Workshop for the Regional Project on Improvement of the Wheat System in Mauritania. The meeting was attended by H.E. Mr. Sidi Mohamed Ould Taleb Amar, Minister of Water and Sanitation, Mr. Ahmed Salem Ould El Arbi, Secretary General of the Ministry of Agriculture, a representative of the Food Security Commission of the Islamic Republic of Mauritania.

The IOFS Attends the 49th OIC Council of Foreign Ministers

is Excellency Pr. Yerlan Alimzhanuly Baidaulet , the Director General of the Islamic Organization of Food Security (IOFS), is leading the IOFS's delegation attending the 49th Session of the Council of Foreign Ministers (CFM) being held in Nouakchott, Islamic Republic of Mauritania, until 17 March 2023 under theme "Moderation: key to security and stability".

Signature of an MoU between the D8 and IOFS on cooperation in agriculture & food security on the sidelines of the 49th OIC CFM

On 18 March 2023 the Director General of IOFS continued to hold meetings on the sidelines of the 49th OIC CFM, including with: H.E. Mrs. Yolande NYONDA, Minister of Foreign Affairs of the Republic of Gabon, discussed the possibility of joining the IOFS at the best convenience and highlighted areas of interest in matters relating to agricultural and food security; H.E. Mr. Nabil Ammar, Minister of Foreign Affairs, Migration, and Tunisians Abroad, where both officials discussed ways and means to improve bilateral cooperation and the process of monitoring the implementation of the Fifth General Assembly resolutions; H.E. Amb. Isiaka Imam, the D8 Secretary General also signed an MoU between the D8 and IOFS on cooperation in agriculture & food security.

IOFS and IFPA Close the Final Day of Agriteq with Six Signing Ceremonies and Invite Participants to the Second IOFS High Level Forum

On the 19th of March in Doha, the AgriteQ Conference and Exhibition 2023 launched with an opening speech from Mr.Saleh A. Lootah, CEO of the International Islamic Food Processing Association (IFPA). Mr. Saleh A. Lootah introduced the audience to a presentation on the strategy of the development of IFPA and the unique B2B platform that has been launched for the Member States of the Organization of Islamic Cooperation (OIC) under aegis of its specialized institution, the Islamic Organization for Food Security, with the aim of enhancing intra-OIC trade and prosperity.

Following the AgriteQ Session on Agricultural Services and Technologies, the Director General of IOFS, H.E. Prof. Yerlan Alimzhanuly Baidaulet delivered a keynote statement on the programs and initiatives of the IOFS and IFPA.

IOFS Holds a High-level Meeting in Qatar and Signs MoU

On 20 March 2023, H.E. Prof. Yerlan Baidaulet began his working visit to Doha, Qatar with a high-level meeting with H.E. Dr. Abdullah bin Abdulaziz bin Turki Al Subaie, Minister of Municipality of the State of Qatar to discuss prospects for strengthening cooperation between the IOFS and Qatar. The Director General also delivered a Keynote Address at the AgriteQ 2023 Exhibition and Conference, followed by a Signing Ceremony with six new IFPA corporate members. The working visit of H.E. Prof. Yerlan Baidaulet concluded with fruitful meetings with the Saudi- based company AlMukarramah, resulting with the signing of an MoU and with UK-based company Soil Association, resulting in the creation of a joint task force for the creation of a Centre of Excellence in Organic Farming.

Director General of IOFS meets with Ambassador of Egypt to Kazakhstan

The Director General of the Islamic Organization for Food Security, HE Prof. Yerlan Alimzhanuly Baidaulet welcomed the Ambassador of Egypt to Kazakhstan, HE Mrs. Manal Elsayed Yehia El Shinnawi to the Headquarters of IOFS, in Astana, Kazakhstan on March 30th, 2023.

The parties discussed the Director General's previous visit to the Arab Republic of Egypt, as well as ways to increase mutual cooperation in various areas, with an emphasis on wheat development. Egypt is actively supporting the IOFS in its activities and intends on building up cooperation with Kazakhstan, the IOFS hosting country.

International Webinar on "CRISPR for Food Security"

The Islamic Organization for Food Security, in cooperation with the Muhammad Nawaz Shareef University of Agriculture, Multan, organized an Online International Webinar on "CRISPR for Food Security" on April 3rd, 2023. The objective of the webinar was to bring together scientists, research scholars, students, and academicians on a single platform to share and enhance the knowledge about the CRISPR technology. The webinar was held to promote interdisciplinary dialogues regarding the contemporary issues in agriculture and food security.

IOFS Kicks Off its In-field Humanitarian Food Assistance Convoy to Afghanistan

On the 15th of April 2023, His Excellency Prof. Yerlan Alimzhanuly Baidaulet, Director General of the IOFS, arrived to the Afghan capital city, Kabul, to commence the in-field implementation of the Organization's Humanitarian Food Assistance to the country, in partnership with the Afghan Red Crescent Society (ARCS). Director General handed over a certificate to the ARCS President, Mawlawi Mutiul Haq Khales, as a symbolic sign for them to start distributing the first IOFS Humanitarian Food Convoy to Afghanistan, which is composed of 280 tons of wheat, and infant supplies.

The Distribution of Wheat Flour and Food Products in Afghanistan, IOFS Signs an Agreement with UNAMA

On the 16th of April 2023, His Excellency, the Director General of the Islamic Organization for Food Security (IOFS) Yerlan Baidaulet, launched the first phase of the Organization's Humanitarian Food Assistance Program "Flour for Humanity" in partnership with the Afghan Red Crescent Society (ARCS). The program is dedicated to deliver to the 'Neediest Houses' (Marastoon) of Kabul and to support orphans of Afghanistan.

Working Meeting of the Deputy Minister of Foreign Affairs of the Republic of Kazakhstan with IOFS and the Ambassador of the Republic of Algeria

On the 18th of April 2023, the Deputy Minister of Foreign Affairs of the Republic of Kazakhstan H.E. Mr. Kanat Tumysh and the Ambassador of the People's Democratic Republic of Algeria to Kazakhstan H.E. Mr. Kamel Feniche, paid a visit to the headquarters of the Islamic Organization for Food Security. The meeting of the three parties included discussions on facilitating IOFS Membership for the Republic of Algeria and prospects for future cooperation. In addition, opportunities for strengthening collaboration with the hosting country were elaborated on.

IOFS Hosts a Reception to Celebrate Eid-El Fitr

On the 21st of April 2023, the Islamic Organization for Food Security hosted its yearly tradition of celebrating Eid Al-Fitr with the esteemed diplomatic corps and local partners in Astana, Kazakhstan. The event gathered representatives from 20 countries, and key partners of IOFS, including: the Ministry of Foreign Affairs and the Ministry of Agriculture of the Republic of Kazakhstan, the Conference on Interaction and Confidence-Building Measures in Asia, UNICEF and more.

IOFS participates in the IsDB Webinar on the Management of the Food Security Crisis & Preparation for the Future

On the 27th of April 2023, the Islamic Organization for Food Security participated in the Islamic Development Bank (IsDB) Webinar on the Management of the Food Security Crisis & Preparation for the Future, the pre-event being dedicated to the topic of food security in view of the 2023 IsDB Group Annual Meeting. The key speakers of the event included, Mr Halil Agah, Executive Director of FCIC, Aamir Mir, PPFM Manager, IsDB, Dr. Azhar Alhaboby, Executive Manager, Hail Agriculture Consultancies- UAE, Ougfaly Badji, Lead Global Food Security Specialist, Prof. Dr. Erdal Akdeve, University of Social Science (Ankara), Director of Social Innovation Institute, and Mr Moncef Ziani, FCIC Vice-President.

IOFS Foreign Media Conference

On the 25th of April 2023, the IOFS had the honor to welcome journalists from over 13 countries to its headquarters in Astana, Kazakhstan. The Director General of IOFS, H.E. Prof. Yerlan Alimzhanuly Baidaulet introduced the media representatives to the mission of the organization, as well as its programs and activities. An emphasis was made on the recent working visit of the IOFS delegation to Afghanistan, to launch the distribution process of the first IOFS Humanitarian Food Convoy. A Question and Answer Session brought the Press Conference to a close, where the sides engaged in an important discussion on global hunger and possible multilateral solutions.

The IOFS aligns visions with UN Resident Coordinator in Kazakhstan for Regional and Global Food Security

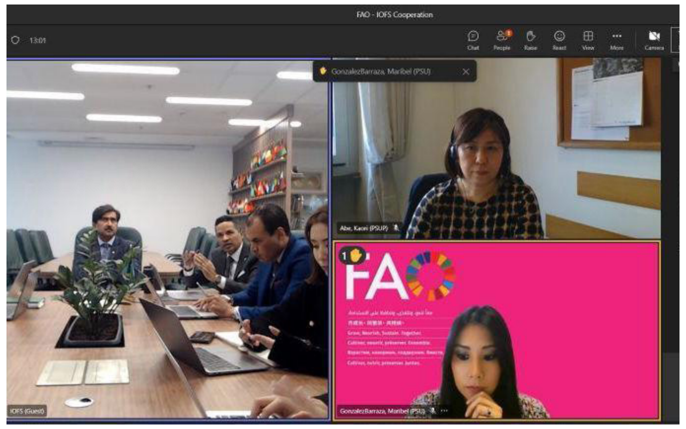
On the 2nd of May 2023, the IOFS Delegation, headed by the Director General H.E. Prof. Yerlan Alimzhanuly Baidaulet held a meeting with the United Nations Resident Coordinator for Kazakhstan, H. E. Ms. Michaela Friberg-Storey. The sides initiated an imperative dialogue on strengthening coordination of the IOFS with various UN organizations in the realm of food security on a regional and global level. Ms. Friberg-Storey highlighted the unique platform IOFS offers to member states and supported the initiatives of the organization in enhancing and developing food systems.

IOFS Meets with High-Level Officials from the Delegation of the Republic of Tajikistan in Astana

The Director General of the Islamic Organization for Food Security H.E. Prof. Yerlan Alimzhanuly Baidaulet met with the Deputy Minister of the Prime Minister of the Republic of Tajikistan, H.E Mr. Ziezoda Sulaimon Rizoi on the sidelines of the Kazakhstan-Tajikistan Business Forum in Astana, Kazakhstan. Both sides exchanged views on strengthening cooperation to reinforce food security in Tajikistan and the region, in general. The Director General also met with the Minister of Agriculture of Tajikistan H.E. Mr. Qurbon Hakimzoda.

IOFS and FAO Hold Follow Up Consultations on Collaboration to Strengthen Food Systems for Member States

On the 3rd of May 2023, the Islamic Organization for Food Security and United Nations Food and Agricultural Organization (FAO) held a virtual meeting to follow up on the high-level consultations the leaderships of the organizations held on 13 October 2022 in Rome, Italy. During the initial meeting, both IOFS and FAO highlighted the shared objective of ensuring food security, sustainable agriculture, and rural development for common Member States. The virtual meeting was arranged to begin the implementation of projects on the ground in several countries based on a country-driven-request approach and relevant mandates that both Organizations hold.



Representatives of the Ministry of Foreign Affairs of the Kingdom of Morocco Visit IOFS HQ

On The 3rd of May 2023, the Ambassador, Director for Asian Affairs and Ocean H.E. S.E. Abdelkader El Ansari and the Ambassador of the Kingdom of Morocco in the Republic of Kazakhstan H.E. S.E. Rachid Maaninou paid a visit to the Headquarters of the Islamic Organization for Food Security. The delegation was welcomed by the IOFS Secretariat, led by the Director General of IOFS, H.E. Prof. Yerlan Baidaulet. The meeting of the parties included discussions on facilitating IOFS programs and projects with the Kingdom of Morocco and prospects for future cooperation in collaboration with African Member States.

Leading Tajikistan Company - Farovon Group Joins IOFS Subsidiary

On May 4th, 2023, H.E. Prof. Yerlan Alimzhanuly Baidaulet, Director General of IOFS and Chairman of IFPA, and Mr. Isroilhocha Samandarov, Director of Farovon Group, signed a Corporate membership agreement with the subsidiary of IOFS, International Islamic Food Processing Association (IFPA). It is important to note that Farovon Group is also a partner of the United Nations Food and Agriculture Organization (FAO).

IOFS PROMOTES STRATEGIC TRANSFORMATION OF SHEEP FARMING DEVELOPMENT

The Islamic Organization for Food Security commemorated the beginning of May by signing an MoU with the Republican Center for Breeding in Livestock "ASYL TULIK" and COWMAS Kazakhstan. The Memorandum initiated a tripartite collaboration to promote animal husbandry, namely, to strengthen pedigree transformation of farm animals (sheep) based on modern breeding methods, information technologies in the specific sphere. Both organizations were able to fully synchronize their strategic visions.

IOFS Participates in the 20th Meeting of the COMCEC Agriculture Working Group

On May 11th, 2023 a virtual meeting was conducted of the COMCEC Agriculture Working Group for "Ensuring the Sustainability of Agricultural Inputs to Combat Food Insecurity in the OIC Member Countries." The meeting provided an opportunity to present and discuss the scope, conceptual framework and methodology of the Research Report, including the main findings of the selected case country analysis and the lessons learned. The meeting started with an emphasis on the importance of agriculture, as the leading sector in the majority of OIC Member States.

Bilateral Meetings in Jeddah, Kingdom of Saudi Arabia

During the course of his official trip to Jeddah, KSA, His Excellency Mr. Yerlan Baidaulet, Director General of the IOFS, conducted a series of bilateral meetings with prominent dignitaries including: Afzal Hussain, Chairman of the Almuarramah, H.E Oussama A. Kaissi CEO of ICIEC, H.E Ambassador Musa Kulaklikaya, ASG on Administration and finance affairs, H.E Amb. Askar Musinov, ASG on Science and technology, H.E Mansur Muhtar, Vice-President of IsDB, H.E Hani Salem Sunbol, CEO of ICD and ITFC, H.E Alamine Ousmane Mey, Minister of the Economy, H.E Amb. Tarig Bakheet, the Assistant to the Secretary General of OIC on Humanitarian Affairs, followed by a meeting with Ms. Mihoko Kumamoto, the Director of the Division for Prosperity at the UNITAR.

3IOFS Launches International Training Workshop on "Addressing the Challenges of Food Security in the Sahel"

From 15-19 May 2023 in Niamey, Niger, the Islamic Organization for Food Security (IOFS) in collaboration with the Standing Ministerial Committee for Scientific and Technological Cooperation (COMSTECH), World Islamic Educational, Scientific and Cultural Organization (ICESCO), Organization of Islamic Cooperation (OIC) and the Permanent Interstate Committee for Drought Control in Sahel (CILSS), is organizing an international training workshop on "Addressing the Challenges of Food Security in the Sahel."

IOFS Opens Expert Meeting on Integrated Water Resources Management Plan for Niger and signs Letter of Intent

On May 15, 2023, the IOFS Director General H.E. Yerlan Baidaulet delivered a keynote address to open the expert meeting on Integrated Water Resources Management Plan for Niger (IWRMP) in Niamey, in coordination with the Ministry of Agriculture of Niger and the High Authority of WAQF in Niger. The Director General noted the gathering as a significant milestone to deliberate upon the key strategies and components of an integrated Water Resources Management Plan, tailored specifically for Niger.

The Director General of IOFS is received by the President of the Republic of Niger and Holds Strategic Meetings with High-level Officials

The extraordinary cooperative relations between the Republic of Niger and Islamic Organization for Food Security (IOFS) were highlighted at a very productive meeting that took place on May 17, 2023, where H.E. Prof. Yerlan Alimzhanuly Baidaulet, Director General of the IOFS, was received in audience by His Excellency Mr. Mohamed Bazoum, President of the Republic of Niger. In a new round of working visits, H.E. Director General Prof. Yerlan Baidaulet held a meeting with H.E. Ouhoumoudou Mahamadou, the Head of the Government of the Republic of Niger. Followed by a meeting with H.E. Mr. Ali Bety, Minister, High Commissioner for the 3N Initiative, Nigeriens Nourishing Nigeriens.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IOFS Continues to Hold Strategic Meetings with High-level Officials in Niger

The Director General of IOFS Prof. Yerlan Baidaulet held several high level meetings in Niamey, Niger. The first bilateral meeting was held with the President of the Niger Chamber of Commerce and Industry, HE Mr. Moussa Sidi Mohamed. The Director General continued his working visit with a meeting with Mr. Tidjani Idrissa, the Minister of livestock of Niger. Then, the bilateral meetings continued for the IOFS Delegation with H.E. Dr Abba Issa Alambédji, Minister of Agriculture of Niger, and with H.E. Mr. Hassoumi Massoudou, Minister of Foreign Affairs of the Republic of Niger.

IOFS Delegation Holds a Round of High-Level Meetings in Tunisia

During a working trip to Tunis, Republic of Tunisia, the Director General of IOFS H.E. Prof. Yerlan Baidaulet met with the Minister of Agriculture, Hydraulic Resources and Fisheries of the Republic of Tunisia, Chairman of the 5th General Assembly of the IOFS, HE Mr. Abdelmonem Belati. The Director General Prof. Baidaulet then proceeded to a meeting with the President of the Tunisian Confederation of Industry, Trade and Handicrafts (UTICA), HE Mr. Samir Majoul. The working visit of the Director General of IOFS concluded with a bilateral meeting with HE Prof. Dr. Mohamed Ould Amar, Director General of the Arab League Educational, Cultural and Scientific Organization (ALECSO - الألكسو).

The First Day of the Working Visit of IOFS Director General in Libya

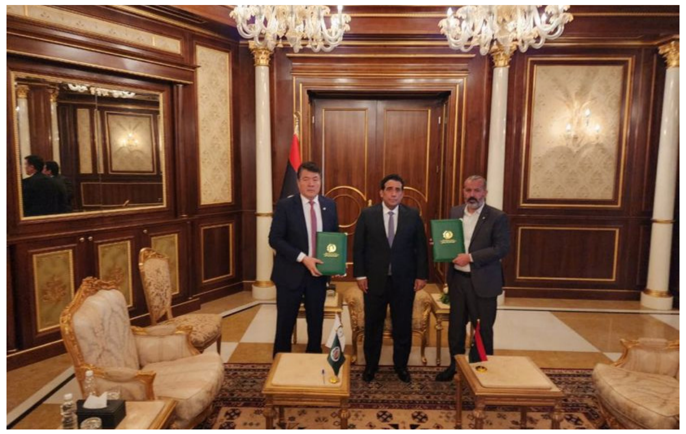
On May 20, 2023, His Excellency Prof. Professor Yerlan Alimzhanuly Baidaulet , Director General of the Islamic Organization for Food Security (IOFS), led an IOFS delegation consisting of Ambassador Daulet Yemberdiyev, Director of Countries Operations Department, and Mr. Sofian Meddeb, Adviser at the Cabinet, started his official visit to Tripoli - the State of Libya, by a field visit to a pilot agricultural farm in the Dafniya region of Misurata, where he was accompanied by His Excellency Mr. Mohamed Khalifa Akika, Undersecretary of the Ministry of Agriculture and Livestock for Technical Affairs and a number of Ministry officials, on the occasion of the beginning of the Wheat harvest season. The field day activities were organized by the Ministry of Agriculture and Livestock, in the presence of local farmers.

The IOFS holds Strategic Panel Discussion in Libya

On 21 May 2023, Professor Yerlan Baidaulet, Director General of the Islamic Organization for Food Security, held official discussions about the activity and needs of the agricultural and livestock sector and brainstormed prospective pathways to enhance food security in Libya, through a panel discussion with all stakeholders in the sector with the participation of representatives of Research institutions in Libya. As a result, a Memorandum of Understanding was signed by the Islamic Organization for Food Security, the Ministry of Agriculture, and the Ministry of Agriculture and Animal Wealth to improve cooperation in the aforementioned areas.

The Director General of the IOFS was received by the President of the Presidential Council of the State of Libya

During the third day of the working visit of the the Director General IOFS, Prof. Yerlan Alimzhanuly Baidaulet to Tripoli, the State of Libya, the delegation of the IOFS delegation was received by His Excellency the President of the Presidential Council, Dr. Mohamed Younis al-Menfi. The meeting provided an opportunity to assess the current agricultural cooperation between Libya and the IOFS and discuss ways to strengthen bilateral cooperation, particularly in the areas of wheat, livestock breeding, and the development of value-added supply chains for animal products. The gathering was attended by His Excellency Eng. Muhammad Muhammad Akika, Deputy Minister of the Ministry of Agriculture and Livestock for Technical Affairs, and His Excellency Mr. Alaeddin Lehwaik, Ambassador of The State of Libya to the Republic of Kazakhstan.



IOFS 2031 Strategic Vision Highlighted at the 39th Follow-up Committee COMCEC

The Director General of the Islamic Organization of Food Security (IOFS) Prof. Yerlan Baidaulet, led the Organization's delegation to the 39th Follow-up Committee of the Standing Committee for Economic and Commercial Cooperation of the Organization of Islamic Cooperation (COMCEC), being held in Ankara, Republic of Türkiye.

The meeting was held to review the activities of different Organization of Islamic Cooperation (OIC) Institutions, including IOFS, in light of the COMCEC Strategy.

Türkiye Reiterates its Support for Timely Execution of the IOFS 2031 Strategic Vision

On 23 May 2023, His Excellency Prof. Yerlan A. Baidaulet, the Director General of the Islamic Organization of Food Security (IOFS), was received at the Office of His Excellency Mr. Ebubekir Gizligider, Vice Minister of Agriculture and Forestry of the Republic of Türkiye, in Ankara to review latest developments related with the Organization's work, as well as the bilateral cooperation in common areas of interest in the field of food security and agricultural development.

IOFS Updates its MoU with SESRIC with Result-Oriented Joint Action Plan

On 24 May 2023, His Excellency Prof. Yerlan Alimzhanuly Baidaulet, the Director General of the IOFS, visited the headquarters Statistical, Economic and Social Research and Training Centre for Islamic Countries (SESRIC) in Ankara, Republic of Türkiye, to meet the Director General, Her Excellency Ms. Zehra Zümrüt Selçuk, to sign an update of the existing memorandum of understanding between the two sister-Institutions of the Organization of Islamic Cooperation (OIC).

Astana Hosts Africa Day Celebrations, Showcases Diversity

ASTANA – Astana hosted Africa Day at the Radisson Hotel on May 25th, showcasing Africa's diversity, cultural and economic potential. The event was initiated by the embassies of South Africa, Libya, Morocco, Algeria and Egypt in Kazakhstan.

South African Ambassador Keitumetse Seipelo Thandeka Matthews opened Africa Day, noting this year is the 60th anniversary of the creation of the African Union (AU).

The Official Inauguration of the International Islamic Food Processing Association (IFPA)

The headquarters of the International Islamic Food Processing Association (IFPA), was officially inaugurated in Dubai, UAE by HE Mrs.Mariam bint Mohammed Almheiri, Minister of Climate Change and Environment of the UAE. The ceremony was held at the Al Etihad Museum, the Guest of Honor included HE Mr. Oussama Abdel Rahman Kaissi, CEO of The Islamic Corporation for the Insurance of Investment and Export Credit (ICIEC). The ceremony also gathered dignitaries, state representatives from Member States and Business Leaders.

IOFS Conducted a Bilateral Meeting and Signed an Agreement to Designate a New CEO for IFPA

Prof. Yerlan Alimzhanuly Baidaulet, Director General of IOFS and Chairman of International Islamic Food Processing Association (IFPA) met with H.E. Mariam Almheiri, UAE Minister of Climate Change and Environment. The meeting was held on the sidelines of the Ceremony of the IFPA headquarters relocation to Dubai. After the IFPA inauguration ceremony, H.E. Prof. Yerlan Alimzhanuly Baidaulet and Mr. Saleh Lootah met in the Dubai Association Centre, following the IFPA relocation event and signed the IFPA CEO designation agreement.

IOFS and IFPA Attend the 13th Annual Meeting of the Aman Union

On the 30th of May 2023, H.E. Prof. Yerlan Alimzhanuly Baidaulet, attends the 13th Annual General Meeting of the Aman Union. The Director General delivered a speech on food security during the session «The impact of the global geopolitical environment on reshaping the global food supply chain and its impact on OIC members.» H.E. Prof. Baidaulet discussed with the session's panelists the key issues of the OIC food supply chain, how the global chain affects OIC Member States, and presented new solutions for addressing the situation. H.E. Eng. Hani Sinbol, CEO - ITFC and acting CEO - ICD, and Dr. Ahmed El Tigani, CEO Al Rawabi Dairy Company, also attended the session.

IOFS and the UN Food Systems Coordination Hub Explore Prospects for Cooperation

Prof. Yerlan Alimzhanuly Baidaulet, Director General of the Islamic Organization for Food Security held a meeting with Mr. Stefanos Fotiou, Director of UN Food Systems Coordination Hub. In a significant step towards cooperation, the delegations of the IOFS and the United Nations Food System Coordination Hub convened via zoom, where they explored prospects for uniting efforts to support and strengthen the strategic positions of Member States.

IOFS Celebrates International Children's Day with Local Schoolchildren

The IOFS prioritizes raising awareness on issues of food security among the youth of Organization of Islamic Cooperation (OIC) Member States. One of the main objectives is to develop the knowledge and talent of youth, to build a sustainable future together. The IOFS captured the opportunity to engage the youth of Astana in the food security agenda by inviting 4th grade students from the Binom School to its headquarters in Astana, Kazakhstan.

IOFS Celebrates World Food Safety Day

IOFS welcomed guests to the 7th expert meeting of the Healthy and Safe Food Ecosystem Program of the IOFS, devoted to the celebration of World Food Safety Day, organized jointly with the Kazakh Agrotechnical University named after S.Seifulin. The meeting gathered experts from: Kazakhstan, the Sultanate of Oman, Pakistan, Kingdom of Saudi Arabia, Jordan, Türkiye, Tajikistan.

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